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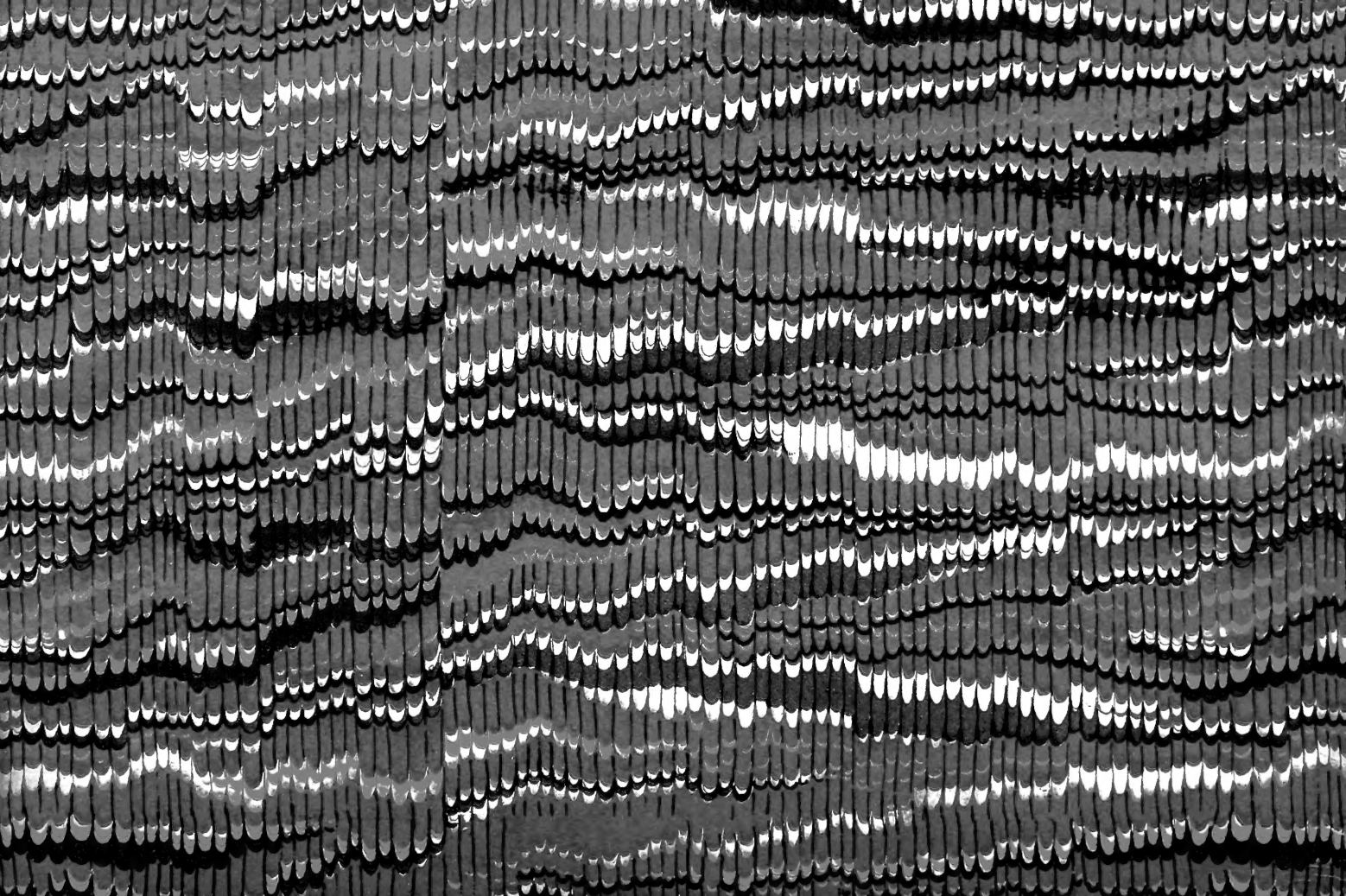

BULLETINS

OF

AMERICAN

PALEONTOLOGY

No. 16

December 8, 1902.

Harris Company
Cornell University, Ithaca, N. Y.
U. S. A.

BULLETINS

OF

AMERICAN PALEONTOLOGY.

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Vol. 4.

BULLETINS
OF
AMERICAN PALEONTOLOGY

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No. 16

EOCENE OUTCROPS IN CENTRAL GEORGIA

BY

G. D. HARRIS.

December 8, 1902.

Harris Company
Cornell University, Ithaca, N. Y.
U. S. A.

SUMMARY OF CONTENTS.

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INTRODUCTION.

Progress in other States.—Through the intelligent exertions of Smith, Aldrich and others, the Tertiary Geology (including paleontology and stratigraphy) of Alabama is fairly well known. Hilgard pointed out the general scheme of Mississippi stratigraphy long ago. Recent surveys are bringing to light the true disposition of the various Tertiary terranes on the Gulf west of the Mississippi.

Georgia behind the other States.—Our knowledge of the Tertiaries of Georgia, however, is most deplorably small. About the Florida line, to be sure, as well as along the Chattahoochee, the Alabama line, a few facts have been noted that are important so far as they go. Spencer while State Geologist, published a map of western Georgia on which the subdivisions of the Eocene, worked out in Alabama, were made to pass up to the northeast in a fairly regular manner to the eastern border of his map. So far as the distribution of the stages of the Eocene is concerned on that map, it is wholly hypothetical and bears almost no semblance to the truth. The beds he represents, upon the Chattahoochee, are very quickly blanketed under a northern extension of the Oligocene as has been indicated, though on a small scale map, in

Bulletin 15, p. 42. This we determined several years ago (See Amer. Geol., vol. 18, 1896, p. 236). We now have good Oligocene collections from Cuthbert, Dawson, Smithville, Americus, Andersonville, and even Rich Hill, north of Fort Valley and east of Roberta. Perry, Haynesville and Hawkinsville are all Oligocene localities.

On the east side of the Ocmulgee, however, along the railway leading back to Macon, imperfect specimens indicate a Lower Claiborne horizon, for the lower country at least.

RECENT INVESTIGATIONS.

Lower Claiborne.

Griswold.—About a year ago, while on our way to take charge of geological work in Louisiana, we collected at some fine fossiliferous localities of this horizon in the vicinity of Griswold, and heard of several others in the same general region but had no time to inspect them. This outcrop is in a V-shaped valley about two miles south of Griswold or about 10 miles east of Macon. The Lower Claiborne rock consists of a hard bed of the typical "buhrstone," of former geological works, about 10 feet in thickness, replete with fossil remains. In less indurated, or in sandy seams, and just below the main bed many fine specimens of silicified shells were collected. Sandy beds were noted below the above-mentioned hard layer for a distance of 40 feet. Above, and between this outcrop and the station, red sandy hills rise to the height of 140 feet above the fossiliferous bed or above the station, the latter two points being upon about the same level. Near the station were noted red sands mottled with white clay. One mile west of Griswold extensive white clay deposits were found along the line of the railway leading to Macon.

Lignitic.

Woods Bluff Beds.

Roberts.—It is, however, to the interesting outcrop near the little station on the railway leading from Macon to Milledgeville, about seven miles in an easterly direction from Macon that we would call special attention in the present paper.

The exact locality is one mile east of the station in a railway cut about 30 feet deep. The light gray sandy clays in the lower

portion of this cut, which become upon drying a light olive gray, remind one at once of the uppermost Lignitic or Woods Bluff beds about Ozark, Alabama, as described in Bulletin 9. We notice that the fossils consist mainly of bivalves, and though seemingly whole while in the wet clay, crumble and fall to pieces on drying or exposure to the atmosphere. They are gone entirely from the upper part of the cut, and their presence there ever might even be questioned.

General stratigraphy of Woods Bluff beds.—Before entering into details regarding this upper Lignitic fauna, we may well devote a little space to a consideration of the geographical position of this outcrop in its relation to outcrops of like age further west.

Specimens recently sent from a well at Sour Lake, Texas, 2,500 feet in depth showed molluscan forms closely related to *Melanopsis planoidea* Ald. and *Ostrea* var. of some of the large Lignitic species.

The Sabinetown bluff we have already identified with the Wood's Bluff beds. But between this locality and Alabama we have seen no traces of an upper Lignitic horizon. We would naturally expect to find such beds constituting the upper strata of the great Lignitic embayment of the Mississippi valley, recently mapped in our Louisiana Survey Report for 1902. Hilgard's identification of fossils from this horizon from the Lake Providence borings we have shown in the Report just mentioned to be erroneous. Farther east the Woods Bluff beds are typically displayed through the second tier of counties from the southern border of Alabama.

Easternmost outcrop.—So far, we are impressed with the extreme southern location of all these beds. Our surprise is therefore the greater when we find this Woods Bluff outcrop 100 miles east and 75 miles farther north than any outcrop ever before known.

That the Lower Claiborne beds take this northeasterly deflection upon crossing the Chattahoochee is well known; though they are often hidden by younger deposits, they do crop out in central Georgia as we have just proven, and come again to the surface in great force in the Carolinas, to feather out again in southern Virginia.

Meaning in Embayment history.—The bearing of these facts

on the history of the Mississippi embayment is at once interesting and important.

The age of the Woods Bluff sub-stage therefore marks the greatest southern retreat of the Gulf's waters during the Eocene era. For the Lower Claiborne seas began to make an inroad upon the area now occupied by western Mississippi, and the Jackson seas reached the region of Crowley's Bluff, Ark., or still farther north. Again the sea or Gulf water was forced back and the Vicksburg beds were deposited over an area strikingly similar to that represented by the Woods Bluff deposits.

Kind of sediment, meaning.—The character of the material composing the Woods Bluff outcrop near Roberts is also well worthy of remark. As a rule, naturally, the Tertiaries along this Archæan border have derived their sediment from the quartz and feldspars so abundant in the crystalline rocks close at hand. In fact the Eocene beds of the eastern part of Georgia, save the buhrstone beds, are composed of rather coarse sand and clays of various kinds and colors, but especially of white or whitish decayed feldspars resembling sometimes the purest kaolins. They are wrought to a considerable extent in this State and South Carolina. Not so with this Woods Bluff bed. Its origin is evidently of a secondary nature or, at any rate, precisely the same as that of the beds of the same age in southern Alabama and at Sabinetown, Texas. This would lead to the inference that there were currents capable to transport earlier Eocene and Cretaceous materials along the shore or in shallow waters from, probably, the Alabama region to central Georgia.

Other Beds and Horizons.

Grovetown.—So far as the general appearance of the lower Tertiary beds are concerned, one has only to visit the vicinity of Grovetown to form a fair idea upon the subject. To the northwest of the railway, and perhaps one-half mile west of the residence of Dr. Hatton, one sees in the lowest stream basins sand beds with much clay and many quartz pebbles. About and above such places are at least 20 feet of similar arenaceous beds though hardened, presumably by calcium carbonate. This whitish rock is used for chimneys and a few other purposes. They seem to contain no fossil remains. Above, however, from 10 to 30 feet come stiff white clays with small bivalve shells and some Bryozoa.

In the harder part of this layer the best fossils are to be found.

At Mr. Reed's place, four miles south of Grovetown, a shaft has been sunk to the depth of 90 feet for prospecting purposes. It started in an impure lignite bed some 20 feet thick though intercalated with clayey layers of varying thickness. Below, appear white rocky ledges from four to six feet thick, presumably of the same horizon as those described one-half mile west of Dr. Hatton's. Still lower are white chalky clays with here and there masses of quartz pebbles; and lowest of all the "chalk" boulders. West of Grovetown, near the 16th milepost on the railway from Augusta, ferruginous sandstone occurs in considerable masses. Purple, pink, white and yellow clays are to be seen in many localities.

The fossils from this locality consist most exclusively of Oyster fragments and a large, long, plicated species of *Modiola*. We prefer to obtain further collections at this place before deciding definitely regarding its horizon.

FOSSILS AT ROBERTS.

As stated above, the fossils near Roberts are not well preserved, but the following species have been identified,:

Venericardia planicosta, *Psammobia ozarkana*, *Lucina* cf. *symmetrica*, *Nucula ovula*, *Protocardia lenis*, var., *Periploma*, smaller, more inflated than *collardi*, *Meretrix* var. *nuttalliopsis*, *Yoldia aldrichiana*, *Volutilithes petrosus*, *? Chysodomus striatus*, *Turritella clevelandia* var.

Vol. III.

No. 11.—The Lignitic Stage. Part 2.—Scaphopoda, Gastropoda, Pteropoda, Cephalopoda. 8°, 122 pp., 12 pls. $2.55

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Price: $3.50.

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Vol. 4.

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 17

THE FAUNAS OF THE TRENTON AT THE TYPE SECTION AND AT NEWPORT, N. Y.

BY

PERCY E. RAYMOND.

December 8, 1903.

Harris Company
Cornell University, Ithaca, N. Y.
U. S. A.

THE FAUNAS OF THE TRENTON AT THE TYPE SECTION AND AT NEWPORT, N. Y.

BY

PERCY E. RAYMOND.

SUMMARY OF CONTENTS.

Introduction.

In the summer of 1900 the headquarters of the Cornell Summer School of Field Geology were at Trenton Falls, New York. Four weeks were spent by Dr. H. F. Cleland, Mr. Tho. A. Caine, and the writer, in a detailed study of the section exposed in the gorge. In the course of the work we collected from each layer, beginning with the lowest; noted the relative abundance of the more common species; and saved specimens from each layer for careful study in the laboratory. Unfortunately such study has not yet been made; but as this is the type section of the Trenton, the writer has thought that perhaps it would be worth while to give the following preliminary note in order to show the range of the common species. The faunal lists are a compilation from the note books which were kept separately, but the writer is responsible for the grouping into faunules. The sixty-eight divisions of the field work have been reduced to sixteen.*

Previous Work.

Theodore G. White, in his Faunas of the Upper Ordovician Strata at Trenton Falls, N. Y.,† gives a short account of the literature of this section, and it is unnecessary to repeat it here. Mr. White's paper contains a detailed section, but is the result of hurried work at an unfavorable time of the year, November.

He divided the section into twenty-three zones. Deducting the first three, which are duplicated, there remain twenty faunal zones, eleven of which are reported as containing more than one species. Only one of these zones was considered sufficiently characterized by any fossil or group of fossils to be mentioned especially, and that was D 21, which was called the zone of *Rafinesquina deltoidea*. It was six feet in thickness and corresponds to the top of M, just below the *Rafinesquina deltoidea* zone of the present paper.

After describing the Rathbone Brook and Poland Limekiln sections, certain conclusions were drawn from a study of the faunal lists. The first three are as follows:

*My thanks are due to Dr. Cleland and Mr. Caine for permission to use the notes.

†Trans. N. Y. Academy Sciences, Vol. XV, pp. 71–96, April 3, 1896.

First: The almost universal prevalence of *Orthis testudinaria*, *Rafinesquina alternata*, *Plectambonites sericeus*,, *Orthoceratites*, *Asaphus platycephalus* and *Calymene senaria* throughout the formation.

Second: The much greater number of forms found in the Black River zones, and in general, also in the lower zones than in those above.

Third: The presence of crinoids; *Prasapora*, *Rhynchotrema inæquivalvis;* and *Trinucleus concentricus*, principally in the lower parts.

The fourth, fifth and sixth are not quoted, as they are not pertinent to the present paper.

Prosser and Cumings* measured the section very accurately and corrected the statigraphy of Mr. White's paper. They made no attempt to divide the section faunally, however.

THE SECTION.

A. 1–20 of field notes. Lower part of A_1 of Prosser and Cumings. Zone of *Triplecia extans*.

Lowest layers exposed in the section. It extends from water level at the Narrows to the footpath. Fine grained, dark gray limestone, in layers from one to eleven inches thick, alternating with thin, shaly layers. About eight and one-half feet below the path is a very fossiliferous layer, from which good specimens of *Trocholites*, *Murchisonia*, *Triplecia*, and the two common trilobites may be obtained. 15 ft. 10 in. = 15 ft. 10 in.

Lingula sp., r,
Trematis terminalis, r,
Dalmanella testudinaria, r,
Rafinesquina alternata, c,
Plectambonites sericeus, rr,
Triplecia extans, r,
Zygospira recurvirostris, r,
Bellerophon bilobatus, r,
Murchisonia gracilis, rr,
Asaphus platycephalus, r,
Calymene senaria, c,
Ceraurus pleurexanthemus, rr,
Leperditia sp., r,
Stictopora sp., rr,
Monticulipora lycoperdon, c,
Ctenodonta levata, r,
Trocholites ammonius, r.
Orthoceras sps., c,
Endoceras sp., r,
Crinoid columns, c.

* Lower Silurian Sections. Fifteenth Annual Report of the New York State Geologist. 1895. Vol. I, p. 619.

B. 21–30 of field notes. Upper part of A_1, P. & C.

This zone extends from the hard layer below the path at Sherman Falls to the first prominent seam in the face of the fall. Irregular beds of quite pure fine grained limestone in layers two to eight inches thick, separated by shaly partings. Contains a few layers of coarser grained, semi-crystalline limestone. The upper 2 ft. 8 in. forms a band which is made noticeable by the nodular appearance of its weathered surface. It contains many fucoidal remains. 9 ft. 9 in. = 25 ft. 7 in.

Lingula rectilateralis, rr,
Trematis terminalis, rr,
Damanella testudinaria, r,
Plectambonites sericeus, r,
Rafinesquina alternata, r,
Zygospira recurvirostris, rr,
Ctenodonta levata, rr,
Bellerophon bilobatus, r,
Murchisonia gracilis, rr,
Asaphus platycephalus, c,
Calymene senaria, c,
Leperditia sp., r,
Stictopora elegantula, rr,
Monticulipora lycoperdon,* c,
Orthoceras sp., r,
Crinoid columns, c.

C. 31 of notes. A_2, P. & C.

Three to five inch layers of more impure limestone separated by shaly partings. Interbedded with these are a few thin, coarsely crystalline layers which are, especially toward the top, full of *Dalmanella testudinaria*. Some of the other layers are made almost entirely of crinoid stems. This zone forms the conspicuous layer in the upper part of Sherman Falls. 10 ft. 8 in. = 36 ft. 3 in.

Trematis terminalis, rr,
Dalmanella testudinaria, c,
Zygospira recurvirostris, rr,
Bellerophon bilobatus, rr,
Monticulipora lycoperdon, c,
Asaphus platycephalus, c.
Calymene senaria, r,
Ceraurus pleurexanthemus, rr.
Leperditia sp., r,
Orthoceras sp., rr,
Crinoid stems, a.

D. 32–42 of notes. A_3 + 2 ft. 5 in. of A_4, P. & C.

Impure shaly limestone at the base, grading into purer blue black layers with shaly partings. Best exposed for collecting on the east side of the stream above Sherman Falls. Most fossilifer-

* This name is used throughout this paper in the same meaning as in Vol. I, Pal. of N. Y.

ous near the top. It includes nearly half of the heavy black layer so prominent along the path between Sherman and Lower High Falls. Zone of *Plectambonites sericeus*. 13 ft. 5 in. = 49 ft. 8 in.

Lingula sp., r,
Trematis terminalis, r,
Dalmanella testudinaria, c,
Platystrophia lynx, rr,
Rafinesquina alternata, r,
Plectambonites sericeus, aa,
Ctenodonta sp., rr,
Bellerophon bilobatus, r,
Asaphus platycephalus, c,
Calymene senaria, c,
Diplograptus amplexicaulis, rr,
Stictopora sp., rr,
Monticulipora lycoperdon, r,
Orthoceras sp., r,
Crinoid columns, c.

E. 43 of notes. Upper part of A_5, P. & C.

Blue black, fairly pure limestone, whose surface becomes very rough on weathering. Best exposed for collecting on east side of stream. *Trilobite* zone. 1 ft. 7 in. = 51 ft. 3 in.

Trematis terminalis, c,
Dalmanella testudinaria, r,
Platystrophia lynx, rr,
Rafinesquina alternata, r,
Zygospira recurvirostris, c,
Bellerophon bilobatus, rr,
Asaphus platycephalus, a,
Calymene senaria, a,
Diplograptus amplexicaulis, c,
Monticulipora lycoperdon, rr,
Orthoceras sp., c,
Crinoid columns, c.

F. 44–46 of notes. Base of A_5, P. & C. F. G. H. and I. constitute the zone of *Monticulipora lycoperdon*.

Dark gray, quite pure layers of limestone, two to six inches thick, alternating with thin shaly layers containing an abundance of the hemispheric forms known as *Monticulipora lycoperdon* Hall. This zone forms the lower layers of Lower High Fall. 6 ft. 5 in. = 57 ft. 8 in.

Lingula sp., rr,
Trematis terminalis, c,
Dalmanella testudinaria, c,
Platystrophia lynx, rr,
Rafinesquina alternata, r,
Plectambonites sericeus, rr,
Zygospira recurvirostris, r,
Bellerophon bilobatus, r,
Asaphus platycephalus, r,
Calymene senaria, c,
Ceraurus pleurexanthemus, rr,
Monticulipora lycoperdon, a,
Stictopora elegantula, r,
Orthoceras sps., c,
Pelecypoda sps., r,
Crinoid columns, r.

G. 47 of notes. Part of A_5, P. & C.

At the bottom is a five inch layer of hard, coarsely crystalline, light gray limestone containing *Cyrtoceras*. Above this are three feet of very fossiliferous shaly and nodular limestone. The remainder of the zone is made up of pure dark gray layers with shaly partings. The limestone contains few fossils, but in the shaly partings *Monticulipora lycoperdon* and *Bellerophon bilobatus* are abundant. 15 ft. 4 in. = 73 ft.

Lingula sp., r,
Trematis terminalis, c,
Dalmanella testudinaria, c,
Platystrophia lynx, r,
Rafinesquina alternata, c,
Plectambonites sericeus, r,
Zygospira recurvirostris, r,
Bellerophon bilobatus, a,
Cyrtoceras sp., rr,
Asaphus platycephalus, c,
Calymene senaria, c,
Ceraurus pleurexanthemus, r,
Stictopora sp., rr,
Monticulipora lycoperdon, a,
Crinoid columns, c.

H. 48–50 of notes. Part of A_5, P. &. C.

Fine grained, bluish limestone in thin layers, with shaly partings, followed by rather unfossiliferous nodular limestone. 8 ft. 6 in. = 81 ft. 6 in.

Trematis terminalis, r,
Dalmanella testudinaria, c,
Rafinesquina alternata, r.
Zygospira recurvirostris, rr,
Bellerophon bilobatus, r,
Asaphus platycephalus, rr,
Calymene senaria, r,
Diplograptus amplexicaulis, rr,
Stictopora elegantula, rr,
Monticulipora lycoperdon, c,
Ctenodonta nasuta, rr,
Orthoceras sps., c,
Fucoids, r,
Crinoid columns, c.

I. 51–54 of notes. Part of A_5, P. & C.

End of the zone of *Monticulipora lycoperdon*.

Three to four inch layers of nodular, impure limestone, separated by rather thick layers of shale. The zone ends with a layer about two and one-half feet thick, which is so nodular as to appear contorted. Fossils not very well preserved anywhere in this mass. 33 ft. 5 in. = 114 ft. 11 in.

Lingula sp., r,
Trematis terminalis, r,
Dalmanella testudinaria, c,
Rafinesquina alternata, r,
Zygospira recurvirostris, r,
Bellerophon bilobatus, c,
Asaphus platycephalus, c,
Calymene senaria, c,
Ceraurus pleurexanthemus, r,
Monticulipora lycoperdon, a,
Stictopora elegantula, rr,
Diplograptus amplexicaulis, r,
Conularia trentonensis, r,
Pelecypoda sps., r,
Orthoceras sp., c,
Endoceras sp., c,
Fucoids, r,
Crinoid columns, c.

J. 55–57 of notes. Top of A_5 and base of A_6, P. & C.

The lower ten feet consist of quite pure, thin bedded dark gray limestone with shaly partings. The upper three feet are very impure limestone interbedded with thick layers of shale. Exposed just above Middle High Fall. The base of the contorted stratum of Theodore G. White, which is also a datum point for Prosser & Cumings' measurements, is 7 ft. 8 in. above the base of this zone. 13 ft. 4 in. = 128 ft. 3 in.

Lingula rectilateralis, rr,
Trematis terminalis, r,
Dalmanella testudinaria, c,
Triplecia extans, rr,
Rafinesquina alternata, r,
Plectambonites sericeus, rr,
Zygospira recurvirostris, r,
Bellerophon bilobatus, c,
Asaphus platycephalus, c,
Calymene senaria, r,
Ceraurus pleurexanthemus, rr,
Conularia trentonensis, rr,
Monticulipora lycoperdon, r,
Orthoceras sp., c,
Fucoids, r,
Crinoid columns, r.

K. 58–59 of notes. Part of A_6, P. & C.

Hard, fine grained, quite pure limestone with shaly partings, grading into a very thin bedded portion. In the lower part *Bellerophon bilobatus* is very abundant and finely preserved, while in the upper third *Dalmanella testudinaria* is dominant, the shale being full of fine specimens. The zone extends to the seam in the cliff of Upper High Fall. Zone of *Bellerophon bilobatus*. 27 ft. 2 in. = 155 ft. 5 in.

Lingula sp., c,
Trematis terminalis, rr,
Dalmanella testudinaria, a,
Platystrophia lynx, a,
Rafinesquina alternata, r,
R. deltoidea, rr,
Plectambonites sericeus, c,
Zygospira recurvirostris, r,
Bellerophon bilobatus, a,
Aasphus platycephalus, r,
Calymene senaria, r,
Ceraurus pleurexanthemus, r,
Diplograptus amplexicaulis, r,
Conularia trentonensis, rr,
Monticulipora lycoperdon, c,
Orthoceras sp., c,
Endoceras sp., r,
Crinoid columns c.

L. 60–62 of notes. Top of A_6 and base of A_7, P. & C.

Somewhat crystalline layers interbedded with shale, ending in an impure nodular layer which is full of crinoid stems. Well exposed on east side of creek at top of High Fall and along the stream to Mill Dam Fall. Zone of *Platystrophia lynx*. 22 ft. 9 in. = 178 ft. 2 in.

Lingula rectilateralis, rr,
Lingula sp., r,
Trematis terminalis, rr,
Dalmanella testudinaria, a,
Platystrophia lynx, aa,
Rafinesquina alternata, c,
R. deltoidea, r,
Plectambonites sericeus, r,
Rhynchotrema inœquivalve, r,
Zygospira recurvirostris, r,
Bellerophon bilobatus, rr,
Asaphus platycephalus, r,
Calymene senaria, rr,
Ceraurus pleurexanthemus, r,
Monticulipora lycoperdon, r,
Pelecypoda sps., r,
Orthoceras sp., r,
Crinoid columns a.

M. 63–64 of notes. Top of A_7 and base of A_8, P. & C.

Pure, fine-grained, black limestone in rather thin layers with shaly partings. Breaks with conchoidal fracture. Well shown in trench dug by the Electric Power Co. Second zone of *Plectambonites sericeus*. 22 ft. 8 in. = 200 ft. 10 in.

Lingula rectilateralis, rr,
Lingula, sp., c,
Trematis terminalis, rr,
Dalmanella testudinaria, c,
Platystrophia lynx, rr,
Rafinesquina alternata, c,
R. deltoidea, c,
Plectambonites sericeus, a,
Zygospira recurvirostris, r,
Asaphus platycephalus, r,
Calymene senaria, r,
Ceraurus pleurexanthemus, r.
Leperditia sp., r,
Monticulipora lycoperdon, rr,
Orthoceras sp., r,
Poteriocrinus gracilis, r,
Crinoid columns, r.

N. 65–66 of notes. Part of A_8, P. & C.

Lithological character the same as M. Well exposed in cliff on west side of the creek near the railroad bridge at Trenton Chasm station. Zone of *Rafinesquina deltoidea*. 26 ft. = 226 ft. 10 in.

Lingula, sp., rr,
Dalmanella testudinaria, a,
Platystrophia lynx, c,
Rafinesquina alternata, r,
R. deltoidea, aa,
Plectambonites sericeus, c,
Zygospira recurvirostris, r,
Asaphus platycephalus, r,
Leperditia sp., r,
Monticulipora lycoperdon, rr,
Crinoid columns, c.

O. 67 of notes. Top of A_8, P. &. C.

Fairly pure, light gray, semi-crystalline limestone in one to six inch layers. Extends to the base of the heavy bedded crystalline rock, and belongs to the same faunal zone with it. Second zone of *Platystrophia lynx*. 17 ft. = 243 ft. 10 in.

Dalmanella testudinaria, a,
Platystrophia lynx, a,
Rafinesquina alternata, r,
R. deltoidea, r,
Plectambonites sericeus, c,
Bellerophon bilobatus, rr,
Asaphus platycephalus, r,
Monticulipora lycoperdon, r.

P. 68 of notes. A_9 of P. & C.

Light gray, coarsely crystalline, heavy bedded limestone, made up largely of the comminuted fragments of brachiopods and crinoid columns. Well exposed in several quarries between Trenton Chasm station and Prospect. 26 ft. = 269 ft. 10 in.

Lingula, sp., rr,
Trematis terminalis, rr,
Dalmanella testudinaria, c,
Platystrophia lynx, c,
Rafinesquina alternata, r,
R. deltoidea, c,
Plectambonites sericeus, r,
Zygospira recurvirostris, r,
Asaphus platycephalus, c,
Calymene senaria, rr,
Ceraurus pleurexanthemus, r,
Stictopora, sp., c,
Monticulipora lycoperdon, c,
Conularia trentonensis, rr,
Crinoid columns, a.

REMARKS.

The measurements give the same total, 270 feet, obtained by Prosser and Cumings.*

It is interesting to note the relative abundance of each of the prominent species through the various zones.

Dalmanella testudinaria.—Rare in A and B, it becomes common in C and D, rare again in E and F, then common all through the rest of the section, its greatest abundance being in K and L, which might be called the *Dalmanella* zone were it not that it remains abundant to the top.

Plectambonites sericeus.—Very rare at the base, it becomes very abundant in D, 35 feet above. From E to K it is again rare, then becomes more common and finally abundant in M, 150 feet above the first *Plectambonites* zone. It remains fairly common to the top.

Rafinesquina alternata.—Common at the base, it becomes rare for a short distance and then fairly common throughout the greater part of the section.

Rafinesquina deltoidea.—This fossil does not appear until the top of K is reached, 130 feet above the base, and then it is rare until it suddenly becomes very abundant in N at 200 feet. In the later zones it is again less common.

Platystrophia lynx.—Absent from the lower 35 feet, then occurs very rarely up to K, when it becomes abundant in L at 175 feet, rare in M, common in N, and abundant again in O and P, making two zones about 50 feet apart.

Triplecia extans.—Found only in the first 15 feet and in J.

Trematis terminalis.—Found rarely all through the section, and is common only in G.

Bellerophon bilobatus.—In all horizons but is more common above the 70 foot level, reaching its culmination in the *Bellerophon* zone at 160 feet. Above that point it is rare.

Asaphus platycephalus.—This trilobite is more common in the lower layers, reaching a maximum in E, only 50 feet above the base. It continues through the remainder of the rock.

Calymene senaria.—About the same history as the preceding. It is most common in the trilobite zone, but may be found in

*Prof. C. S. Prosser gives 275 ft. as the result of a later measurement.

almost any layer, though it is rare in the upper part, L to P. Good enrolled specimens were obtained from the *Bellerophon* zone, on the east side of the creek, and from the first *Platystrophia* zone, on the west side.

Ceraurus pleurexanthemus.—Very rare in the lower part and, though not common, occurs in almost every zone above E.

THE FAUNAS OF THE BASAL TRENTON IN THE VALLEY OF WEST CANADA CREEK.

From the section at Trenton Falls one turns naturally to the sections near Newport on West Canada Creek, where the lower Trenton, lacking at the type section, is well exposed. Both Theodore G. White, 1896, and Prosser and Cumings have described the lithological character of the beds at this place, but neither give the fauna of the lower limestone, though the latter mention the occurrence of fossils in the Birdseye and list the following species:

Phytopsis tubulosa Hall, *Murchisonia* cf. *varicosa* Hall, *Orthoceras multicameratum* Con., *Modiolopsis* sp., *Rafinesquina alternata* (Con.) Hall and Clarke, *Leperditia* sp., *Stictopora* sp., and a gastropod.*

There are three localities in the vicinity at which Birdseye fossils are common. One is in a ledge in the bank of the creek near the railroad-cut about half way between Newport and Poland. The second is in a quarry a short distance west of the railroad station at Newport. The third is in the smaller quarry at the Moshier workings. This is the one described in this paper, and was selected because the fossils were better preserved than those collected at the river bank, and the section is more complete than that near the Newport station.

SECTION.

Moshier quarry. One mile north of the Newport station, Herkimer Co., N. Y.

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*Lower Silurian Sections. 15th Annual Report of the State Geologist. Vol. 1, p. 627.

1. Beginning with the lowest layers exposed in the small quarry near railroad track. Pure, dove-colored limestone in three heavy beds. The small variety of *Phytopsis tubulosus* is present in large numbers. Fossils few. This is Birdseye limestone ; the contact with the Calciferous not shown. 2 ft. 9 in. = 2 ft. 9 in.

Dalmanella testudinaria, c,
Zygospira recurvirostris, r,
Primitia logani, r,
Leperditia fabulites, r,
Leperditia, small sp. c.

2. More sandy layers, with numerous poorly preserved fossils. A three inch bed in the middle is made up of much-rounded sand grains. 1 ft. 8 in. = 4 ft. 5 in.

Trochonema umbilicatum, r,
Asaphus, sp. und. r,
Primitia logani, r,
Leperditia fabulites, r,
Leperditia, small sp. c.

3. Pure dove colored limestone containing many pelecypods. No "birdseyes." Good collecting. 1 ft. 6 in. = 5 ft. 11 in.

Rafinesquina alternata, c,
Strophomena incurvata, c,
Zygospira recurvirostris, c,
Ctenodonta levata, r,
Whitella ventricosa, r,
Cuneamya subtruncata, c,
Trochonema umbilicatum, c,
Orthoceras arcuoliratum, r,
O. multicameratum, r,
Oncoceras constrictum, r,
Asaphus platycephalus, r,
Primitia logani, r,
Leperditia, small sp.

4. Pure limestone, breaking with conchoidal fracture. The layers are mostly about five inches thick. *Phytopsis tubulosus* is common, but there are no other fossils except a few specimens of the small *Leperditia*. 2 ft. = 7 ft. 11 in.

5. Coarsely crystalline limestone. 5 in. = 8 ft. 4 in.

Modiolopsis faba, c,
Calymene senaria, r.

6. Dark gray, fine grained, pure limestone. Fossils not abundant. 2 ft. 6 in. = 10 ft. 10 in.

Ctenodonta dubia, c,
C. levata, r,
Rafinesquina alternata, r,
Leperditia, small sp. r.

7. Light gray, fine grained, pure limestone in about six inch beds. 2 ft. 4 in. = 13 ft. 2.

Zygospira recurvirostris, r,
Fusispira subfusiformis, r,
Murchisonia milleri, r,
Cuneamya subtruncata, r,
Whitella ventricosa, r,
Dalmanites callicephalus, c,
Asaphus platycephalus, r,
Leperditia, small sp. r.

8. Thin bedded, pure limestone, with earthy partings. Much broken up by weathering. Top of small quarry. 2 ft. = 15 ft. 2 in.

Dalmanites callicephalus, c, *Asaphus platycephalus*, c.

9. Covered to floor of main quarry. About two feet. 17 ft. 2 in.

10. Heavy bedded, characteristic Birdseye limestone, carrying no fossils. It splits readily into very regular blocks and is much quarried. 3 ft. = 20 ft. 2 in.

11. Impure, thin, shaly limestone, with neither fossils nor calcite-filled tubes. 6 in. = 20 ft. 8 in.

12. Pure, thin bedded (about four to six inch beds), light buff limestone, filled with *Phytopsis tubulosus*. This is the top of the Birdseye, but there is no bedding plane between it and No. 13. The dividing line is marked by a very abrupt change from light to dark color and is very noticeable in the walls all around the quarry. The *Phytopsis* tubes stop exactly at the top of the light colored rock. 2 ft. 8 in. = 23 ft. 4 in.

13. Dark gray, lumpy, fairly pure limestone, with numerous fossils. Black River. 5 ft. 6 in. = 28 ft. 10 in.

Monticulipora lycoperdon, r,
Stictopora elegantula, c,
Fenestella, sp. und. r,
Dalmanella testudinaria, r,
Dinorthis pectenella, r,
Rafinesquina alternata, c,
Strophomena incurvata, c,
Camarella cf. *polita*, r,
Rhynchotrema iæquivalve, r,
Zygospira recurvirostris, r,
Ctenodonta levata, c,
C. nasuta, c,
Modiolopsis trentonensis, r,
M. faba, r,
M. arcuata, r,
Raphistoma americana, c,
Holopea cf. *ophelia*, r,
Ormoceras tenuifilum, r,
Illænus americanus, r,
I. arcturus, r,
I. ovatus, r,
Bumastus trentonensis, c,
Asaphus platycephalus, r,
Dalmanites callicephalus, r,
Ceraurus pleurexanthemus, c,
Calymene senaria, r,
Bathyurus extans., r,
Leperditia fabulites, c,
Leperditia, small sp. r,
Primitia logani, r,
Murchisonia gracilis, r,
M. milleri.

In the piles of waste material in the quarry many fine specimens can be found, and the following species, not seen in No. 13, were collected from blocks of undoubted Black River limestone:

Columnaria alveolata,
Camarella, sp. und.,
Cuneamya subtruncata,
Whitella ventricosa,
Lituites americanus,
Orthoceras arcuoliratum,
Fusispira subfusiformis,
Bathyurus spiniger,
Harpina, sp. nov.

CONCLUSION.

Of the twenty-one species found in the Birdseye, three only, *Trochonema umbilicatum*, *Oncoceras constrictum*, and *Orthoceras multicameratum*, were not found in the immediately succeeding beds. Eleven of the twenty-one occur in the Trenton at Trenton Falls.

It is interesting to note that although the Calciferous and Birdseye here grade into one another so that, as Prosser and Cumings remark, it is difficult to draw any sharp line between them on lithological grounds, yet there is so great a change in conditions between the two that none of the species of the Upper Calciferous (Fort Hunter*) fauna pass into the lowest Trenton.

There is a marked similarity between this Black River fauna and that of the same formation at Crown Point, N. Y.† Of the forty-one species identified from zone 13, twenty-eight are found in the Crown Point fauna. Of the remaining species twelve are are rare and one, *Bumastus trentonensis*, is common. In the Crown Point fauna there are only nine species which do not occur at Newport. Four of these are rare, and five, *Plectorthis plicatella*, *Streptelasma corniculum*, *Dalmanella subæquata pervetus*, *Stromatocerium rugosum* and *Triplecia extans* are common. *Streptelasma corniculum* and *Stromatocerium rugosum* are common in the Black River of other sections in the Mohawk Valley and should be found here.

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*See Bull. Am. Pal. No. 13.

†See Bull. Am. Pal. No. 14, pp. 21–24 and 30.

SUMMARY.

This paper is intended to show the following points.

In regard to the Trenton Falls section:

First. That though most of the common species range through the whole mass, as White has remarked, yet there is such a variation in the relative abundance of these species in the various zones as to make up faunules which can be easily recognized.

Second. That at least two species, *Platystrophia lynx* and *Rafinesquina deltoidea*, have limits to the range in which they are common.

Third. That the upper third of the mass contains the greatest number of individuals, but about the same number of species as the lower part.

Fourth. That the brachiopods and trilobites form the most important part of the fauna. The pelecypods are rare except locally.

In regard to the Newport section:

Fifth. That when the "Birdseye" is fossiliferous its fossils are practically the same as the Black River, or, that these two faunules are more closely related to each other than either is to the Trenton above.

Sixth. That in these lower faunules, the pelecypods are as important in individuals and species as the brachiopods.

Seventh. That the Black River has a fauna which would enable one to recognize it even if *Columnaria alveolata* were absent.

Eighth. That the fauna of the Black River in this locality is very closely related to the Black River of the Champlain province.

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FURTHER NOTES ON THE CALCIFEROUS (BEEKMANTOWN) FORMATION OF THE MOHAWK VALLEY, WITH DESCRIPTIONS OF NEW SPECIES

BY

H. F. CLELAND

December 23, 1903

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Cornell University, Ithaca, N. Y.
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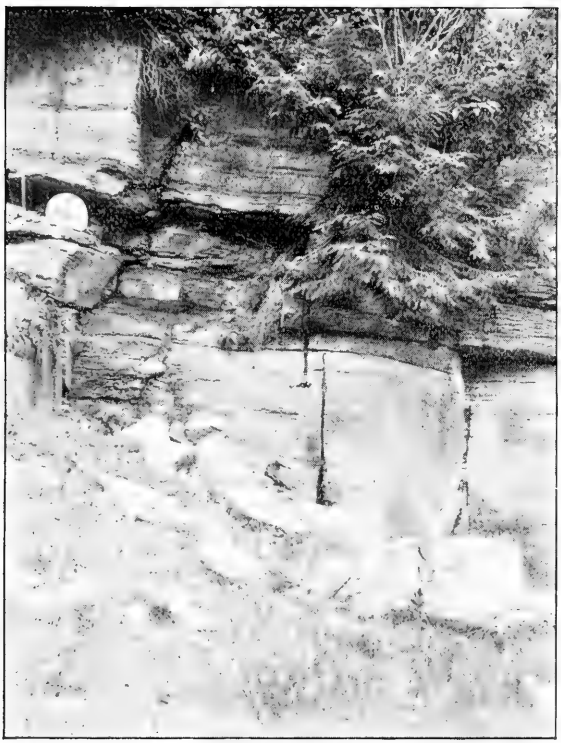

A Fossiliferous Locality, Trióes Hill, N. Y.

The hat shows the position of rich bed.

FURTHER NOTES ON THE CALCIFEROUS (BEEKMANTOWN FORMATION OF THE MOHAWK VALLEY, WITH DESCRIPTIONS OF NEW SPECIES

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SUMMARY OF CONTENTS

Introduction.

The discovery of a fauna, rich in species and individuals, in the Calciferous formation of the Mohawk Valley of New York, near the village of Ft. Hunter,* led to the publication of a paper describing the fauna and new species of this section. The present paper is the result of a few weeks' work in the Mohawk Valley, during which the writer endeavored to trace the distribution of the fauna and to obtain a more complete faunal list. The writer takes this opportunity to thank Prof. G. D. Harris for his kindness in figuring the fossils described in this paper.

Sections.

Ft. Hunter–Tribes Hill Section.

Collections were first made from all the exposures of the strip of the Calciferous formation shown on the map (Pl. 2). The contacts between the Calciferous, Trenton and Utica formations were carefully traced and mapped by Mr. W. M. Cooper and the writer. This strip begins about a quarter of a mile south of the Mohawk River and east of the village of Ft. Hunter, where it is about a mile wide, and extends about three miles north, the width varying from about one mile to one-fifth of a mile. The Calciferous formation is brought to the surface on the east by a fault, which can be traced by an almost continuous escarpment from the river to the most northern point shown on the map. It undoubtedly extends further north, but the country is so covered with drift that the rock is hidden. The Calciferous and Utica formations are exposed together in but one place on the fault line, in the bed of the creek which parallels the "Lutheran church road" near Clark's quarry. In this place the formations are within a few feet of each other, the Utica shale being tilted up at a high angle.

The Calciferous formation of this region is overlaid, in some places, by a thin bed of Birdseye (Lowville) limestone, in others

* American Paleontology, Vol. 3, Bull. 13, Oct. 1900.

by the Black River limestone; but in some sections the Trenton limestone seems to be in contact with the Calciferous, and the Birdseye and Black River are wanting. (This determination depends entirely upon the lithological character of the rock.) The fossiliferous beds are, with one exception, found within 45 feet of the contact with the Trenton limestone. The rock containing the abundant fossil fauna has a very characteristic appearance. It weathers to a light gray and in this respect differs from the greater portion of this formation which weathers yellow. The fossils are found in the purer limestone at the partings of the beds. These beds occur throughout the Ft. Hunter–Tribes Hill region, at Canajoharie, and were last met with in a thin bed near the top of the formation at Little Falls. They are usually largely made up of water-worn limestone pebbles. The most abundant fossils throughout are *Riberia nuculitiformis* and *turgida*; *Ophileta levata*, *Pleurotomaria hunterensis*, and *Raphistoma obtusa*. In many cases the fossils appear to be much water-worn.

These fossils are in Prof. C. S. Prosser's "B 4" * of the Tribes Hill section, which he characterizes as follows: "Strongly fucoidal, massive beds of bluish-gray color, capped by a blue thin layer containing *Ophileta complanata* Van."

The only other bed in this section which was found to contain fossils is one 90 feet below the Trenton limestone in the bank of the creek which flows north of the Methodist church in the village of Tribes Hill. This bed is replete with fragments of *Asaphus canalis* (?) Conrad, but no other fossils were collected from it.

The Ft. Hunter–Tribes Hill section was worked with considerable care, but the region to the west was visited very hastily and a number of localities not mentioned in this paper will, without doubt, be found by more careful search.

The Tribes Hill section, in detail, is as follows:

A_1. 1 in. Bed of pyritiferous limestone containing abundant fragments of *Asaphus canalis* (?) Con. This bed is a part of a shaly bank (unusual in this formation) in which are several thin layers of limestone, only one of which was found to contain fossils.

A_2. 53 ft. Mostly covered.

* 15th Ann. Rept. N. Y. State Geologist, p. 645.

A_3. 3 ft. 1 in. In the bed of the creek which flows across the road north of the Methodist church in Tribes Hill village, 60 yards above the stone bridge and 4 feet below the top of the bridge the Calciferous limestone is exposed. In hand specimens the rock looks like a fairly pure limestone with occasional sandy seams. Some layers are conglomeratic and contain water-worn pebbles. The fauna is as follows:

Ribeiria nuculitiformis a.	*Asaphus canalis* (?) cr.
Bathyurus (?) *ellipticus* cr.	*Harrisia parabola* r.
Raphistoma obtusa ca.	*Dalmanella wemplei* cr.
Callograptus salteri (?) r.	Crinoid stems and plates r.

A_4. 7 ft. 5 in. Rock more arenaceous than the last. Fossils rare. *Ecculiomphalus multiseptarius* is quite common near the upper portion. Natural sections of gasteropods are fairly common in the wall of the quarry.

A_5. 2 ft. 6 in. This is the extremely fossiliferous bed which also occurs at Ft Hunter and Canajoharie. The rock is more or less conglomeratic and oölitic and falls to pieces on weathering. Upon exposure the rock changes from a compact blue limestone to a loose iron stained rock from which the fossils, especially *Ribeiria nuculitiformis*, are easily broken out. The iron stains are due to the oxidation of pyrite, which is plentiful in the rock. Many of the specimens seem to be water-worn. The species found are:

Ribeiria nuculitiformis a.	*Pleurotomaria hunterensis* r.
R. turgida cr.	*Pleurotomaria* sp. cr.
Harrisia parabola r.	*Ecculiomphalus uultiseptarius* r.
Bathyurus (?) *ellipticus* r.	*Dalmanella wemplei* r.
B. levis r.	*Orthoceras primigenium* (?) r.
Ophileta levata c.	Crinoid stems r.

A_6. 4 ft. The light gray fucoidal limestone gives place to a heavy bedded arenaceous limestone which weathers buff. On the upper surface of this bed is a one inch conglomerate layer containing a few fossils:

Ophileta levata r.	*Ribeiria nuculitiformis* r.
Dalmanella sp. r.	Crinoid plates r.

A_7. 7 ft. 7 in. Weathers light gray with irregular stratification planes. The following fossils were found:

Pleurotomaria hunterensis r.	*Dalmanella* sp. r.

A_8. 12 ft. 8 in. Compact calcareous sandstone which is very hard and breaks with a conchoidal fracture. No fossils.

A_9. 4 in. A four inch layer of compact gray limestone underlies the Black River limestone. It may be, and probably is, the Birdseye (Lowville) limestone. It contains no fossils or "birdseye" markings.

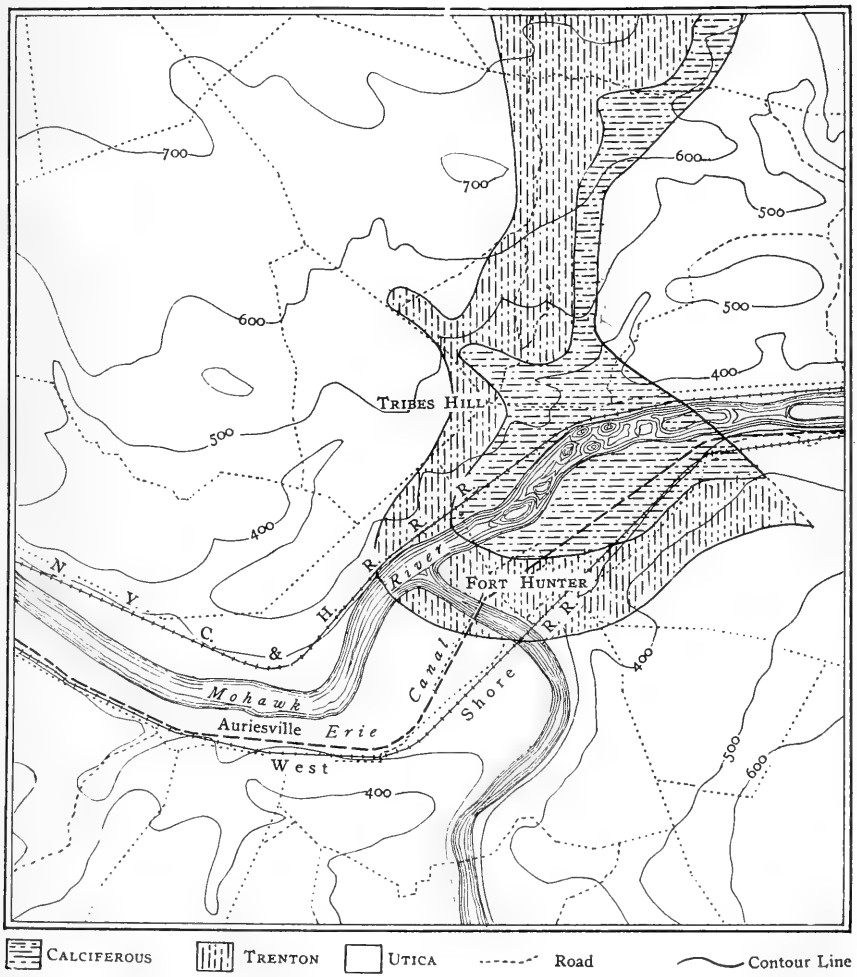
A_{10}. 4 ft. 8 in. Black River limestone. Very lumpy and weathers more rapidly than the Trenton. It is difficult to draw the line between the Trenton and the Black River, and the line drawn is a more or less arbitrary one. The Trenton is more crystalline than the Black River and contains a somewhat different fauna but there is no sharp break between them in this section. No specimens of *Columnaria alveata* were found in this section, but this species occurs in considerable abundance in a quarry a half mile east.

A_{11}. 7 ft. 6 in. Trenton limestone. Crystalline and thin bedded. The large, irregular pebbles spoken of by Prof. C. S. Prosser and Vanuxem as sometimes occurring at the base of the Trenton are found here, one pebble was almost a foot in diameter. The fauna is a characteristic Trenton one.

Canajoharie Section.

On the farm of Mr. William Allen, near the village of Canajoharie, one-quarter mile west of the West Shore station, is an old quarry in which about 40 feet of the Upper Calciferous is exposed. The rock is very much as at Tribes Hill and Ft. Hunter, but the fossiliferous beds are thicker. These beds are in the lower 20 feet of the section. The following species were found:

Lingula ovata cr.
Dalmanella wemplei cr.
Pleurotomaria hunterensis r.
Ecculiomphalus multiseptarius r.
Ophileta levata a.
Bellerophon calcifer r.
Raphistoma obtusa c.
Murchisonia sp. r.
Cyrtoceras gracilis r.
Holopea sp. r.
Bathyurus (?) *ellipticus* r.
B. levis cr.
Harrisia parabola cr.
Asaphus canalis (?) cr.
Ribeiria nuculitiformis c.
R. nuculi. var. equilatera r.
R. turgida a.



Map of Ft. Hunter-Tribes Hill Region.
Topography from U. S. G. S.
Geology by H. F. Cleland.
Scale 1 inch = 1 mile.

Lack of time prevented the writer from visiting the quarries at Palatine Bridge and Ft. Plain, but the same fauna and order will doubtless be found there.

St. Johnsville Section.

In an old quarry by the power-house dam on the east side of East Canada Creek, 4 miles above St. Johnsville (about 25 miles west of Ft. Hunter) occurs the light gray fucoidal limestone similar to that farther east. The exposed surfaces of these beds weather to a soft, friable sandstone. On one of these surfaces a fauna quite rich in individuals was found. The exposures were not favorable for collecting, but the following species were found :

Lingula ovata r. *Dalmanella wemplei* (?) r.
Pleurotomaria hunterensis c. *Ophileta levata* r.
Ecculiomphalus multiseptarius cr. *Murchisonia mohawkensis* cr.
Orthoceras primigenium r.

Three Miles South of Ingham Mills.

In a creek bed 3 miles south of Ingham Mills a slab of sandstone 4 inches thick was found which contained 15 or 20 lamellibranches (*Edmondia* (?) *arcuata*). The rock was not in place but could not have been moved far, as was shown by the edges which were sharp and not water-worn. The lithological character of the rock was similar to that of the immediate vicinity. No rock of this character exists in the north, so it could not have been brought down by the ice.

Little Falls Section.

At Little Falls two fossil localities were found, both in the upper part of the series. The uppermost bed was within 10 feet of the contact with the Birdseye (Lowville) limestone. This bed was a medium gray limestone about 4 inches thick containing a few water-worn pebbles. Fragments of *Asaphus canalis* (?), very much broken, were common. *Ophileta levata* was occasionally found and a single specimen of *Lingula ovata*. This bed seems, from its lithological character and position in the section, to be a continuation of the Ft. Hunter beds.

The second fossil bed in this section was in chert, a small portion of which contained a large number of gasteropods. These specimens were kindly loaned by Mr. C. H. Flory, of Columbus, Ohio, who collected them in 1899, A search in the same ledge failed to bring any other specimens to light. The species are as follows :

Turbo dilucula (?) cr.
Holopea (?) *voluta* r.
Tryblidium patulum r.
Holopea (?) *raymonda* cr.

Descriptions and Distribution of Species.

In the identification of the specimens described in the paper on the "Calciferous of the Mohawk Valley"* the writer was obliged to depend upon the illustrations as given in Billing's Palæozoic Fossils, Hall's Paleontology of N. Y. Vol. I, 1847, and the Am. Mus. Nat. Hist. Bull. Vols. I and II. The illustrations in the first two references are poor and the descriptions very brief ; in consequence one of the species described as a new species was, on comparison with the type specimen, found to belong to a described species. Of this, correction will be made in the following discussion.

Crustacea.

TRILOBITA.

Bathyurus (?) **levis** sp. nov. Pl. 3, figs. 1, 2.

Bathyurus (*?*) sp. Am. Pal., Vol. 3, Bull. 13, 1900, p. 17, pl. 16, fig. 9.

Glabella oblong, very convex, eyes midway between the front and back. Surface smooth. In the most perfect specimen a portion of the fixed cheek curves obliquely downward back of the eyes. Free cheeks and thorax unknown. In the specimen figured (pl. 3, figs. 1, 2,) a structure which has the appearance of an "ocellus" (o) is seen. It is situated in the middle of the glabella directly between the eyes. In Prof. C. E. Beecher's† paper on the "Structure and Appendages of Trinucleus" he

* Am. Pal. Vol. 3, Bull. 13, 1900.

† Am. Jour. Sci., 3rd Ser., April, 1895, p. 309.

figures this structure and says that "although the nature has not been fully demonstrated it has generally been called an ocellus." Only one of our specimens showed this structure. The specimen figured is an adult. Although a large number of specimens of this species has been found, they are all in a poor state of preservation.

The characters of the glabellas of this species are so distinct from that of any other figured species that it has been placed in a new species. The pygidium figured in Bull. 13, Pl. 16, Fig .4, as *Asaphus convexus* (?) may be found, upon further investigation, to be the pygidium of this species.

Localities.—In the upper portion of the Calciferous formation at Ft. Hunter, Tribes Hill, and Canajoharie, N. Y.

Bathyurus ellipticus Cleland. Pl. 3, Fig. 3.

B. ellipticus, Am. Pal., Vol. 3, Bull. 13, 1900, p. 17; pl. 16, figs. 5, 6.

A pygidium, which is probably that of this species, was found at Tribes Hill. The description is as follows: Pygidium minute, semi-circular, sloping evenly to the margin, equally lobate, border thickened and moderately wide. The axis is composed of four annulations and tapers regularly to an obtuse, rounded termination. Pleura broad and bear four annulations which are faintly grooved near the distal extremities. Surface rough.

Distribution.—Occurs in the upper portion of the Calciferous at Ft. Hunter, Tribes Hill, and Canajoharie, N. Y.

Harrisia parabola Cleland. Pl. 3, Figs. 4, 5.

H. parabola, Am. Pal., Vol. 3, Bull. 13, 1900, p. 15, pl. 16, figs. 1, 2, 3.

The pygidium of this species had not been found when the species was first described. The following description is based upon several pygidia associated with the cephalons of this species found at Tribes Hill, N. Y. Pygidium subtriangular; the posterior extremity truncated, very convex, sloping rapidly to the lateral and posterior margins. Border thickened and convex, broad in proportion to the size of the pygidium. The measurement of the largest specimen is 5 mm., of the smallest 1½ mm.

Distribution.—As far as known this species occurs only in the upper portion of the Calciferous formation of the Mohawk Valley of N. Y.

Asaphus canalis (?) Conrad.

Isoletes canalis, Pal. N. Y., Vol. 1, 1847, p. 25, pl. 4 bis., figs. 17–19.
Asaphus canalis, 12th Report N. Y. State Cabinet, p. 70.
Asaphus canalis, Am. Mus. Nat. His. Bull., Vol. 1, No. 8, 1886, p. 336, pl. 34, figs. 1–8. *Ibid.*, Vol. 11, No. 2, 1889, pp. 64, 65, pl. 11, 12.
Asaphus canalis (?), Am. Pal., Vol. 3, Bull. 13, p. 16, pl. 16, fig. 7.

This trilobite, as far as we can judge from our collections, has a greater distribution vertically and geographically than any other species in the Mohawk Calciferous.

Distribution.—At Tribes Hill it occurs in a bed 90 feet below the Trenton and in several horizons to within a few feet of the contact with the Trenton. Geographically, it extends from Little Falls throughout the Mohawk and is reported from the Lake Champlain region.

PHYLLOPODA.

Ribeiria.

The uncertainty which has existed regarding the relationship of this genus has been cleared up by the recent investigations of Schuchert and Waagen.* According to these investigators *Ribeiria* is a crustation which is closely related to the modern *Apus* and is placed in the family *Apodidæ* and order *Branchiopoda* of the *Phyllopoda*.

Ribeiria turgida sp. nov. Pl. 3, Figs. 6, 7.

A variable species but one very distinct from *R. nuculitiformis* was found, more or less abundantly, in several localities in the Mohawk Valley. The following is the description of these species: Carapace small, equilateral; the largest about 9 mm. in height and 12 mm. in length. Sides very convex. None of the specimens preserve the carapace. In the cast a deep notch extends obliquely posteriorily toward the ventral side. Dorsal margins straight or slightly curving. The ventral margin is almost semi-circular in outline. This species differs from *R. nuculitiformis* in its strong convexity and in being equilateral.

* Dr. R. J. Schuchert and Dr. D. L. Waagen "Jahrbuch der K. K. geolog." Reichstalt, 1903. Bd. 53, Heft. 1. Pp. 33–50. Taf. 1.

Distribution.—Especially abundant in the Canajoharie section. It also occurs at Ft. Hunter and Tribes Hill. The distribution of *R. nuculitiformis* is the same as that of *R. turgida*, but it is more abundant in the Tribes Hill-Ft. Hunter region.

Ribeiria, sp. (?)

A fragmentary specimen of a *Ribeiria* which differs from both *R. turgida* and *R. nuculitiformis* in the acuteness of the anterior and from *R. turgida* in the flatness of the carapace, was found at Canajoharie.

Mollusca

CEPHALOPODA

Cyrtoceras gracilis, sp. nov. Pl. 3, Fig. 10.

Cyrtoceras sp., Am. Pal., Vol. 3, Bull. 13, 1900, p. 19, pl. 17, figs. 5, 6.

When this species was first described there was some doubt as to whether it belonged to a new species or not. An examination of more material leads to the conclusion that the species had never been described. The specimens are all fragmentary but show little variability. The description given in the above cited paper is as follows: "A small specimen 12 mm. long and 8 mm. in diameter with 5 septa to 3½ mm. can not be placed with any described species." A more careful description is now added: Shell slender, arcuate. Transverse section oval. The tube appears to taper regularly. The septa are close together, 5 to 6 septa in 4 mm. being the average. The extent of the chamber of habitation and the aperture were not observed. Septa smooth and slightly concave. The siphuncle is small and close to the ventral side (pl. 3, fig. 10). The septa are bent on one side toward the chamber of habitation, as is well shown in the figure (Bull. 13, pl. 17, fig. 5).

C. acinacellum Whitfield (Bull. Am. Mus. Nat. His., Vol. 1, p. 327, pl. 27, figs. 10–13) differs from it principally in the siphuncle, which is situated near the outer margin. *C. microcopium* Dwight (Am. Jour. Sci., 3rd Ser., Vol. 27, p. 256, fig. 11) has the septa closer together. In *C. dictys* Billings (Pal. Fos., Vol. 1, p. 192, fig. 176) the septa are much farther apart.

Distribution.—In the upper part of the Calciferous at Ft. Hunter, Tribes Hill, and Canajoharie, N. Y.

Orthoceras primigenium Vanuxem Pl. 3, Figs. 8, 9.

O. primigenium, Vanuxem, Geol. Rept. 3rd Dist. N. Y., 1842, p. 36, fig. 4.
" " Pal. N. Y., Vol. 1, 1843, p. 13, pl. 3, figs. 11, 11a.
" " Am. Mus. Nat. His., Bull., Vol. 2, p. 56, pl. 10, fig. 1.
" " Am. Pal., Vol. 3, Bull. 13, 1900, p. 20.

Up to this time the siphuncle of this species has not been described. The siphuncle of a very good uncrushed specimen found at Tribes Hill was situated within half a millimeter of the edge of the shell, was elliptical, the greatest diameter being 3 mm. and width 2 mm, The cross-section of the shell is elliptical, the greatest diameter being 11 mm. and width 8 mm.

Distribution.—Common on the weathered surfaces of the upper portions of the section at Canajoharie, Ft. Hunter, Tribes Hill, East Canada Creek, Yosts, and other parts of the Mohawk Valley.

GASTEROPODA

Holopea (?) **voluta,** sp. nov. Pl. 3, Fig. 11.

Shell of medium size, height 11 mm. and the transverse diameter 16 mm. Volutions three, increasing rapidly in size with the growth of the shell. The volution near the aperture is angular in cross-section, the angulation being sharp on the periphery. The upper volutions do not show the angulation, but this may be due to the fact that the shell is embedded in the matrix to some extent. The coils seem to be discrete, but of this there is some question. Umbilicus and aperture unknown. The shell is embedded in chert which makes its separation from the matrix impossible.

Distribution.—This specimen was collected by Mr. C. H. Flory from a cherty layer in the upper middle portion of the Calciferous on the hill south of Little Falls, N. Y.

Turbo (?) **dilucula** Hall

Turbo dilucula Hall, Pal. N. Y., 1847, p. 12, pl. 3, fig. 7.

A number of specimens which are probably of this species were found in the cherty bed at Little Falls. Concerning the occurrence of this species Hall says: "This fossil occurs in great num-

bers in the siliceous portions of the rock", and "it occurs in the lower and middle parts of the mass." Our specimens were found in the upper middle portion of the section, but they were not in great numbers.

Holopea (?) raymondia, sp. nov. Pl. 3, Figs. 12, 13.

Shell rather flat, spire elevated but little above the outer volution, sometimes nearly on the same plane; volutions three or four, enlarging very gradually from the apex; aperture and surface unknown. Diameter of two shells 5 mm. and 10 mm. respectively. *Turbo dilucula* Hall enlarges very rapidly and the spire is much elevated in comparison with *H. (?) raymondia.*

Distribution.—A number of specimens of this species were found at Little Falls, but none were in a perfect state of preservation. Collected and loaned by Mr. C. H. Flory.

Tryblidium patulum, sp. nov. Pl. 3, Figs. 14, 15.

Shell small, having a length of 10 mm., a width of 6 mm., and a height of 3 mm. The specimen may be slightly compressed laterally, in which case the proportions will be slightly different. The general outline of the aperture is oval with the greatest width posteriorly. Apex anterior, narrow and curved, very slightly elevated above the margin, if at all, and projecting beyond it. The shell is strongly convex transversely and, in our specimen, the sides are almost parallel near the aperture. In the longitudinal section the curve is greatest on the anterior and decreases rapidly toward the posterior. Surface unknown.

This species resembles *T. simplex* Whitfield (Am. Mus. Nat. His. Bull., Vol. 1, No. 8, pl. 24, figs. 30, 31, p. 366), but differs from it in several particulars. It is smaller, the beak does not project beyond the body of the shell as in *T. simplex* and the outlines of the aperture is widest posteriorly.

Distribution.—A single specimen was found in a cherty bed at Little Falls, N. Y. (See *H. voluta.*)

Ophileta complanata Vanuxem

O. complanata, Geology Third District N. Y., 1842, p. 36, fig. 2.
" " Pal. N. Y., Vol. 1, p. 11, fig. 3 and pl. 3, fig. 6.
" " Am. Mus. Nat. His., Bull., Vol. 2, p. 48, pl. 7, figs. 18 to 25.
Schizostoma complanata, N. Y. State Mus., Bull. 65 1903, p. 561.

The description given by Vanuxem is as follows: "[*O. complanata*] consist[s] of many convolutions resembling a single coil

of cord formed on a flat surface, the diameter of the coil being usually about an inch." "From analogy of formation it evidently appertains to the same genus with *O. levata*." "It is more rare than *O. levata* but is occasionally met with in the same localities on the Mohawk."

In the collections from the Mohawk Valley no specimens which correspond to the above description were found. Occasionally weathered specimens of *Pleurotomaria hunterensis* are found in the localities mentioned by Vanuxem and Hall which present the appearance of a flat coil. In the State Museum at Albany some of the specimens labelled *O. complanata* are unquestionably *P. hunterensis*. The type specimen has apparently been lost.

There is little doubt that *P. hunterensis* has usually been identified as *O. complanata* in the Mohawk Valley for the past fifty years. *Ecculiomphalus multiseptarius* is a rarer form but has probably also often been called *P. complanata*.

The appearance of weathered specimens (see pl. 4, fig. 1) gives the impression of a "flat coil" and it is possible that Vanuxem's description is incorrect, but until the type specimen is found this can not be proved.

Pleurotomaria hunterensis Cleland. Pl. 4, Figs. 1, 2.

Am. Pal., Vol. 3, Bull. 13, 1900, p. 12, pl. 17, figs. 1, 2, 7, 8.

The localities given by both Vanuxem and Hall for *O. complanata* are the same as those in which our species occurs. In these localities no fossil which resembles *O. complanata* was found except the above species. Vanuxem's description is so plain that had the distribution been different there would have been no doubt as to the determination.

Distribution.—Found occasionally on the weathered surfaces of the Calciferous in many parts of the Mohawk Valley: Ft. Hunter, Tribes Hill, "The Noses" near Yosts, Canajoharie, St. Johnsville, East Canada Creek, and Little Falls.

(See discussion under *O. complanata*.)

Ophileta levata Vanuxem.

O. levata, Geology of the Third Dist., N. Y., 1842, p. 36, fig. 1.
" " Pal. N. Y., Vol. 1, p. 11, fig. 2, pl. 3, figs. 4, 5.
" " Am. Mus. Nat. Hist., Bull., Vol. 2, p. 48, pl. 7, figs. 18–25.
O. discus, Am. Pal., Vol. 3, Bull. 13, p. 12, pl. 15, figs. 5, 6.
Schizostoma levatum, N. Y. State Mus., Bull. 65, 1903, p. 561.

Vanuxem describes this species as "a small spiral undescribed univalve." The whorls or coils are more numerous and slender than those in the woodcut and the central ones are raised, not being in the same plane. "It was observed at all the localities of these layers (fucoidal layers) on the Mohawk."

A comparison of the species figured as *O. discus* with the type of *O. levata* showed that they are of the same species. The figures of Hall and Vanuxem are both of the under side of the specimen and are very inaccurately drawn. The hypotype in the State Museum is labelled "Canajoharie" and is associated with *Ribeiria nuculitiformis*. At Canajoharie these species are abundant. Prof. Whitfield's figures of *O. complanata* and *O. levata* (Am. Mus. Nat. His. Bull., Vol. II, pl. 48, pl. 7, figs. 18 to 25) show that both are distinct from *O. levata*. His specimens do not have the sharp margin on the edge of the whorls or the elevated spire. Although specimens from the Calciferous formation of other states have been identified as *O. levata*, I have seen none which were correctly identified as such.

Distribution.—This species is especially abundant at Ft. Hunter, Tribes Hill and Canajoharie. It also occurs at Little Falls, East Canada Creek and the "Noses" near Yosts.

Ecculiomphalus multiseptarius Cleland.

Am. Pal., Vol. 3, Bull. 13, 1900, p. 11, pl. 15, figs. 1 to 4.

Without doubt this species has often been identified as *O. complanata*. It frequently occurs on weathered surfaces. There is considerable doubt as to the relationship of certain small loosely coiled shells which are figured in Bulletin 13 of Am. Pal., pl. 15, figs. 3, 4, as the young of *E. multiseptarius*. These small forms are very abundant in certain localities, but no forms intermediate between them and *E. multiseptarius* were found in the collections. Until more or better material is available it seems best to include them in the above species.

Pleurotomaria (?) **floridensis** Cleland.

Am. Pal., Vol. 3, Bull. 13, p. 13, pl. 15, fig. 12.

This species is a rare one in all of the localities where collections were made. It was found at Ft. Hunter and Tribes Hill.

Raphistoma obtusa Cleland

Am. Pal., Vol. 3, Bull. 13, 1900, p. 13, pl. 15, figs. 7. 8, 9.

This well marked species was found abundantly in the upper portion of the Calciferous in the Ft. Hunter-Tribes Hill region where the specimens are large. At Canajoharie the species is much smaller and less abundant.

Murchisonia mohawkensis Cleland

Am. Pal., Bull. 13, p. 14, pl. 15, fig. 13.

This species, which was very rare in the Ft. Hunter collection, is one of the commoner fossils in other sections. At Clark's quarry north of Tribes Hill, at the "Noses" near Yosts, and at East Canada Creek it was found on weathered surfaces.

Bellerophon calcifer Cleland

Am. Pal., Vol. 3, Bull. 13, 1900, p. 14, pl. 15, figs. 15, 16, 17, 18.

B. calcifer is a rare species, being found only at Ft. Hunter and Canajoharie and rarely in these sections.

LAMELLIBRANCHIATA

Edmondia (?) **arcuata**, sp. nov. Pl. 4, Figs. 5, 6, 7.

Shell of medium size, sub-rectangular in outline, length about one-third greater than the height. Basal margin nearly straight curving to the anterior and posterior extremities. Posterior margin curving abruptly below and more gently toward the cardinal line. Cardinal margin (apparently) almost straight; anterior margin narrower than the posterior and curving less abruptly.

Valves convex and gibbous in the umbonal region. Beaks at about the anterior third, prominent and incurved. Umbonal slope soon merging into the general convexity of the shell.

The surface in one specimen is marked by concentric lines, but the shell is not well enough preserved to warrant a definite statement on this point. Two specimens measured 29 mm. in length and 22 mm. in height.

Distribution.—Three miles south of Ingham Mills in a creek bed. The rock in which the specimens were found was not in place but could not have been moved far, as was shown by the external con-

dition of the slab. The edges of the slab were sharp and showed no evidence of being water-worn. The character of the rock is similar to that in the immediate vicinity. The highest rock, stratigraphically, through which the stream flows, and to the north, is the Utica shale. The slab contained 15 or 20 specimens.

Molluscoidea

BRACHIOPODA

Lingula (?) **ovata**, sp. nov. Pl. 4, Fig. 3.

General form of the shell ovate, with the greatest length 7 mm. and width 5 mm. Rather strongly and uniformly convex. Surface marked by concentric lines. A great many fragments of this species were found, but only two perfect specimens. It is with considerable hesitancy that these specimens are referred to a new species. There is a strong resemblance to *L. iole* Billings (Pal. Fos. Vol. 1, p. 215, fig. 1), but *L. iole* is smaller, more triangular, and is distinctly striated. The brachial valve of *L. acuminata* Conrad (Pal. N. Y., Vol 8, pt. 1, pl. 1, fig. 1,2) also resembles this species. Our specimens have somewhat the same shape but are more arched, less acute, smaller, and show no striæ.

Distribution.—Found occasionally in the upper portions of the Calciferous at Ft. Hunter, Tribes Hill, Canajoharie, and East Canada Creek.

Dalmanella wemplei Cleland.

Am. Pal. Vol. 3, Bull. 13, 1900, p. 17, pl. 17, figs. 10, 11, 12, 13.

Distribution.—This species occurs at Tribes Hill, Ft. Hunter, the "Noses" at Yosts, East Canada Creek, Canajoharie, and will probably be found at Palatine Bridge and to the west. *D. macleedi* Whitfield resembles this shell very closely, but the surface of the type specimen is so poorly preserved that it does not seem well to include it in that species. It is possible that when

more perfect material is obtained from the Lake Champlain Calciferous that this species may prove to be *D. macleodi.* This is, however, doubtful.

Syntrophia palmata Cleland

Am. Pal., Vol. 3, Bull. 13, 1900, p. 18, pl. 17, figs. 14 to 17.

S. palmata is confined to the Ft. Hunter-Tribes Hill region so far as our present knowledge goes.

BRYOZOA (?)

Stromatopora (?)

Beds of limestone and chert from a few inches to a foot or more in thickness full of *Stromatopora (?)* occur at Little Falls, St. Johnsville, and elsewhere in the Mohawk Valley. No attempt at a specific determination was made.

Echinodermata

CRINOIDEA

Crinoid stems and plates

Well preserved plates apparently identical with those figured by Vanuxem in the Geological Report of the Third District of New York, were among the commonest fossils on weathered surfaces.

Distribution.—The distribution is the same as for *Pleurotomaria hunterensis.*

Cœlenterata

GRAPTOLITES

Callograptus salteri (?) Hall Pl. 4, Fig. 4.

Geol. of the Quebec Group, p. 135, pl, 19.

Three specimens of this graptolite, in a poor state of preservation, were found in bed A_3 at Tribes Hill. They were referred to Dr. Ruedeman who identified them as *C. salteri (?).* This species was not found in any other place.

Plate 3

EXPLANATION OF PLATE 3.

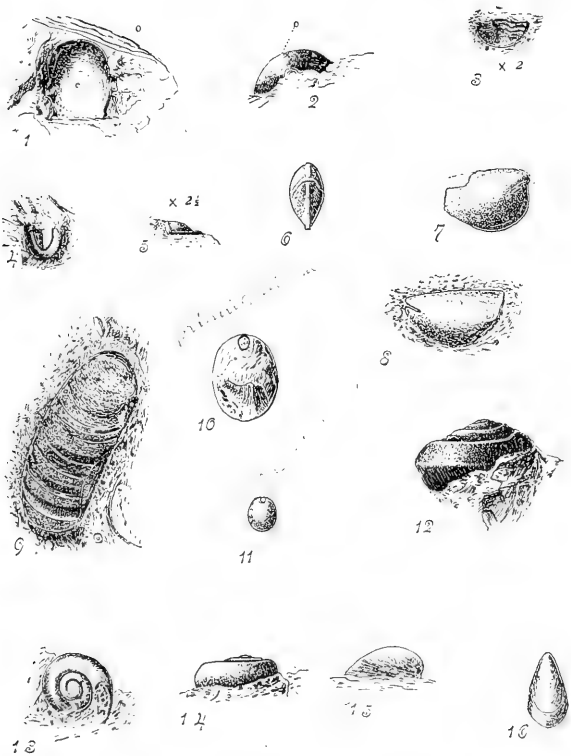

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Plate 4

EXPLANATION OF PLATE 4

Page

Fig. 1. *Pleurotomaria hunterensis* Cle..... 16, **42**
This figure shows the characteristic coiled appearance of the weathered specimen which are commonly seen on weathered surfaces.

2. A section through the apex of an imperfect specimen showing the position of the whorls and the width of the umbilicus.

3. *Lingula ovata*, sp. nov..... 19, **45**
Ventral (?) valve of a perfect specimen.

4. *Callograptus salteri* (?) Bill..... 20, **46**
A cast of the exterior.

5. *Edmondia* (?) *arcuata*, sp. nov..... 18, **44**
Right valve of an unusual form.

6. Right valve of a typical specimen.

7. Left valve of the usual size.

Taf. Am. Hal. Vol. 1. Pl. 1.

BULLETINS

OF

AMERICAN

PALEONTOLOGY

No. 19

October 2, 1904

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Cornell University, Ithaca, N. Y.
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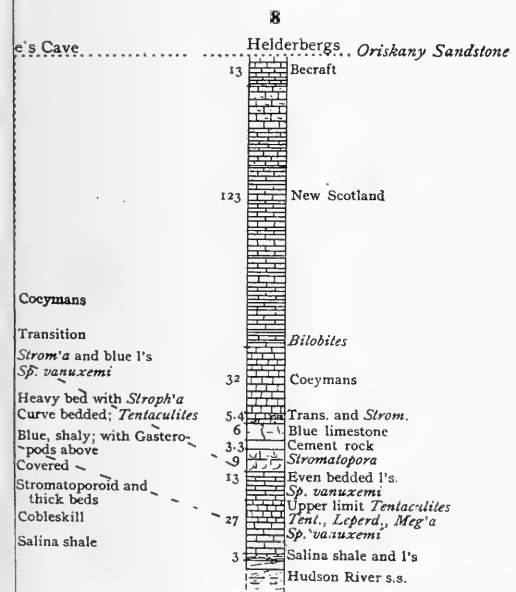

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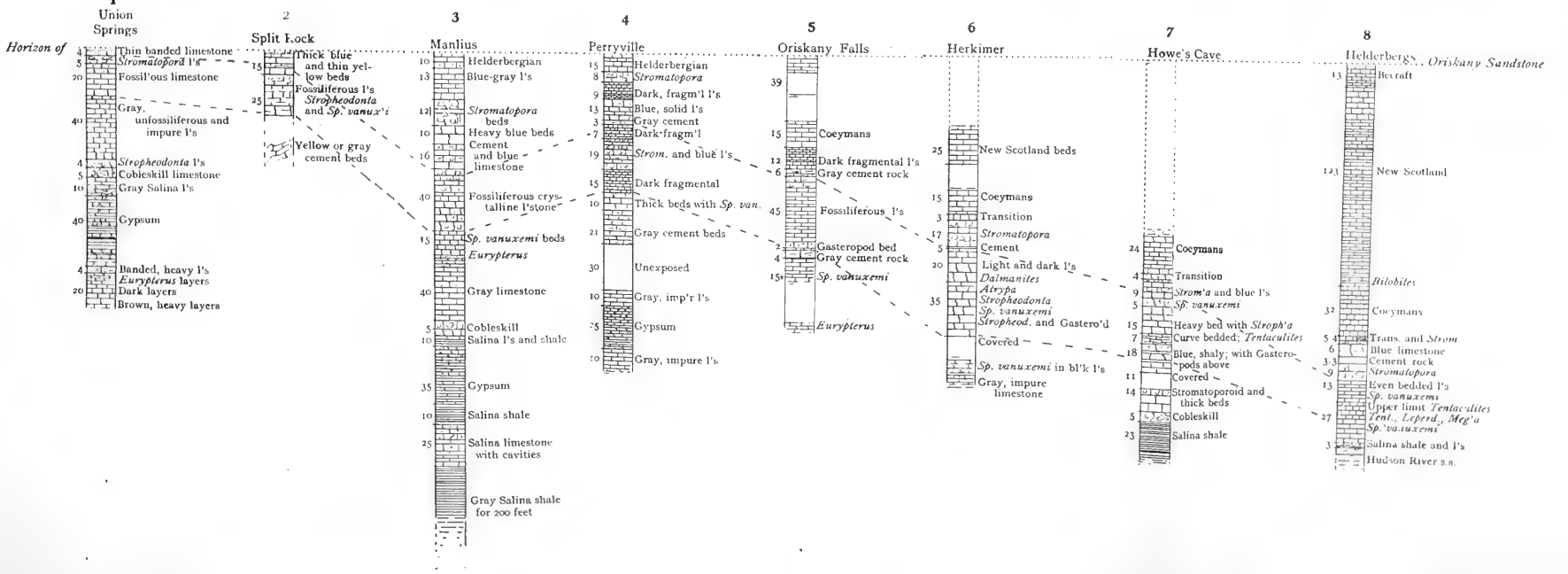

Sections showing the development of the Manlius stage throughout east-central New York. The broken lines include that portion of the stage to which special attention is called in this Bulletin.

Vol. 4

BULLETINS
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No. 19

THE HELDERBERG INVASION OF THE MANLIUS

BY

G. D. HARRIS

October 2, 1904

Cornell Univ., Ithaca, N. Y.
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THE HELDERBERG INVASION OF THE MANLIUS

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SUMMARY OF CONTENTS

ILLUSTRATIONS

THE HELDERBERG INVASION OF THE MANLIUS

Introduction

By glancing at Plate I it will be seen that several sections in or across the Manlius stage have been studied extending from "1, Union Springs" to "8, Helderberg Mts." The dotted line at the top indicates the position of the Oriskany sandstone. Measurements of the thickness of beds are expressed in feet to the left of each columnar section, while to the right is a brief reference to faunal or stratigraphic features.

Before beginning a detailed description of each section, it may be stated that a similar study was undertaken by Prof. S. G. Williams and his results were published in the American Journal of Science, 1886, vol. 31, p. 139–145. Subsequent investigations have shown that this author was scarcely warranted in his general conclusions regarding the age and proper correlation of the great masses of limestone between the gypsum beds and Oriskany in central New York, for he believed them to be locally modified Helderbergian deposits, and hence above the Manlius series. But this much must be said in his behalf, viz., that he alone has seemed to grasp the true stratigraphic relations of the various deposits about Union Springs, and he alone has emphasized the importance of the Oriskany Falls section in the elucidation of Manlius and Helderbergian stratigraphy. As we proceed, we shall see that there is also a slight flavor of truth in even his general conclusions as referred to above; for the title of the present article is such as to show that the relations of Manlius and Helderbergian faunas, are, so far as time goes, perhaps not quite so distant as has generally been supposed.

I. Union Springs

Eurypterus Limestone.—The Eurypterus limestone of the Salina is well shown at two localities near Union Springs: 1st along the Lehigh Valley R. R. track from the Plaster Mills to ½ mile east of Cayuga Junction; 2d, in the bed of the creek but a few yards north of Cross Roads Station. At the former locality there is a slight southerly or south-easterly dip so that by following the stream bed just east of the Junction nearly to the highway the section as given on Pl. 3, No. 4 can be made up. The upper portion of the section may also be seen in the outcrops on the north side of the railroad track; in fact here is the place

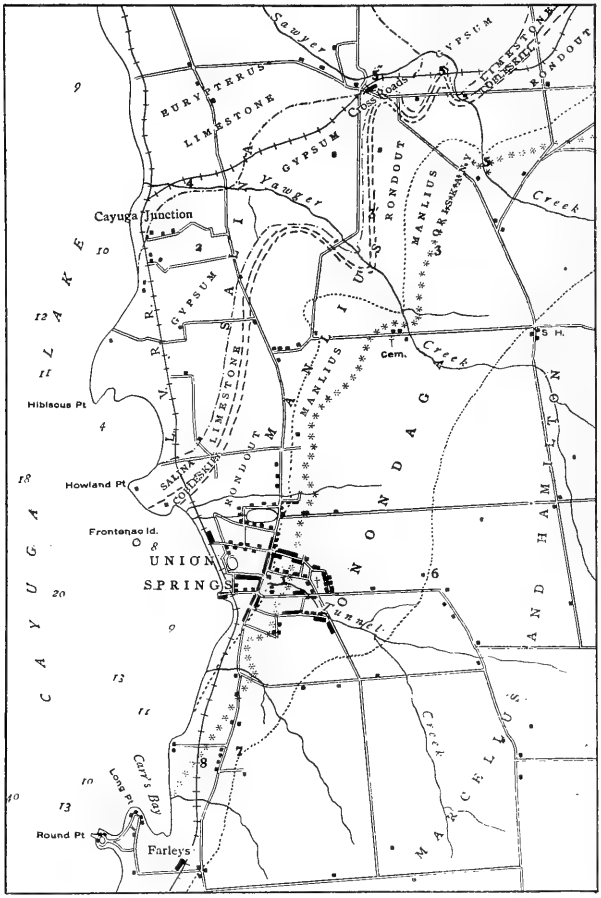
where *Eurypterus* is generally most easily collected.

Note especially the heavy brownish beds at base and the hard, banded gray and blue, heavy unfossiliferous bed on top. So far as our observations go, fossils are limited to the *Eurypterus* bed as indicated in the section. They are besides *Eurypterus*, *Leperditia alta*, and *Stropheodonta* (? *Orthothetes interstriatus*). In the stream bed back of the old mill at Cross Roads, the middle-upper part of this section may be seen, and *Leperditia* is of common occurrence, but *Eurypterus* remains are rare. (See basal part of No. 5, Pl. 3.) Up the stream half way to Thompson's old quarry it will be observed that the hard, banded limestone described above caps the *Euryperus* substage. The dark bands seem to indicate the change of conditions taking place and the introduction of gypsum deposition. While at the old mill just mentioned, note should be made of the southward dipping limestone layers in the opposite bank of the creek, for as will be seen later this point has an important bearing on what follows regarding the true relationship of these limestones to those above the gypsum. The easternmost exposure of the *Eurypterus* limestone is about half-way between Cross Roads and Thompson's old quarry. The beds are below the exposure in the quarry and the dip is to the east.

Gypsum beds.—At Thompson's old quarry one sees the section shown on Pl. 3, Fig. 5 (middle portion). Skirting the southern edge the Cobleskill limestone with a bed of *Stromatopora* appears. Then below are 10 feet of grayish waterlime beds with a *Lingula*, *Discina*, and several other forms. Below are 4 feet of irregularly bedded and banded limestone; and still lower, 18 ft. of gypsum extending to water level in the quarry. To what extent the gypsum extends below the water level we cannot state. But judging from the apparent depth of the water and the eastward dip of the *Eurypterus* beds just to the west, it is evident that a thickness of 30 ft. would not be too great for this deposit. Elsewhere, east of the Plaster Mills very extensive excavations have been made in this deposit.

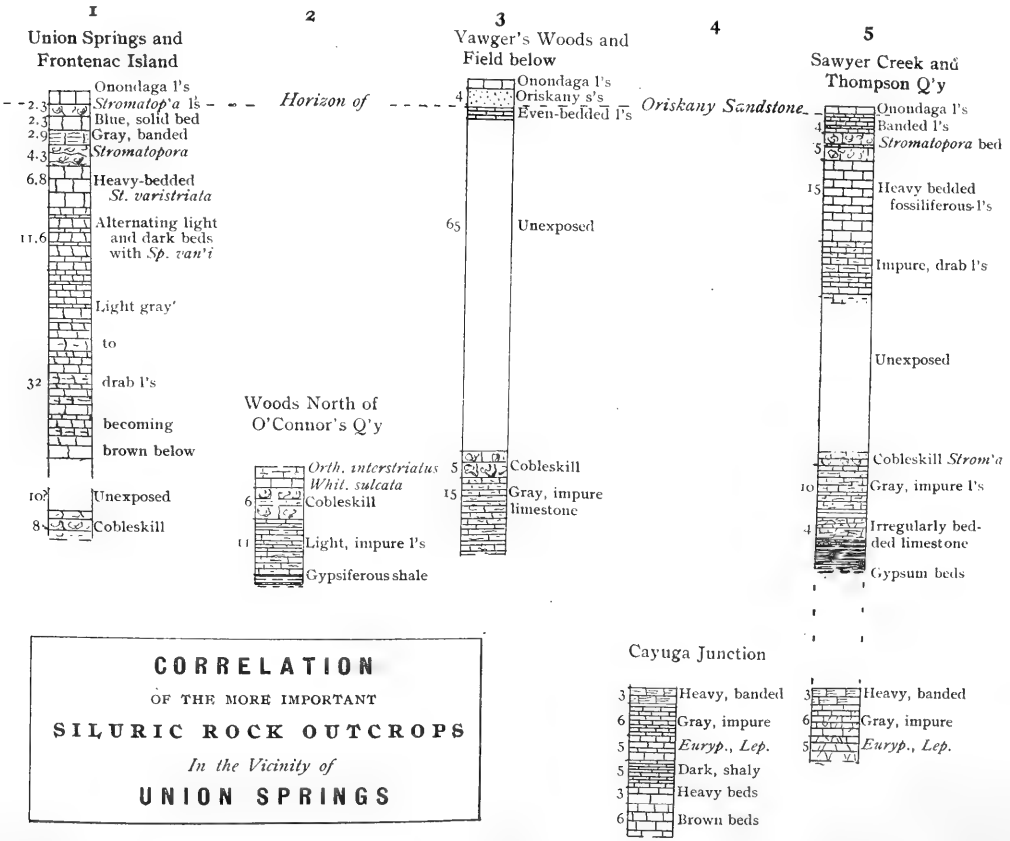
The plate herewith given (Pl. 4) shows an abandoned quarry with its characteristic pond of water. It lies half way between Hibiscus Pt. and the railroad track. So far as we are aware, the gypsum beds are unfossiliferous.

The thickness of these deposits is a matter of considerable un-



Geological map of Union Springs and vicinity. The heavy faced numerals refer to the location of important outcrops. The lighter, indicate the depth of the lake in feet. Lake level, 380 ft; highest point on map 770 ft. above tide.

Bull. Am. Mus. Nat. Hist. Vol. 4, Art. 7: Pl. 19, Fig. 2



CORRELATION

OF THE MORE IMPORTANT

SILURIC ROCK OUTCROPS

In the Vicinity of

UNION SPRINGS

certainty. We have never had the pleasure of seeing the quarries drained so as to measure the depth to which the deposit extends. Williams has assigned it an average thickness of 25 ft. But, inasmuch as a workman at the Plaster Mills says the quarry has a face of 50 ft. when drained, and since the dip is considerable in a southerly direction at Cross Roads, and east at a point a few hundred feet west of Thompson's old quarry where the *Eurypterus* rock disappears beneath the gypsum horizon, it is quite evident that in places a thickness of 40 ft. may well be assigned to these deposits.

We should observe in passing that Clarke and Luther have unfortunately considered the outcrop of the gypsum deposits in this region as due to a local anticline, bringing them up to the surface, while the *Eurypterus* limestone and the few feet of thin gray shaly Salina limestone just below the Cobleskill are considered as one and the same deposit, flanking the anticline north west, and south-east. The fallacy of this interpretation is at once evident when one looks carefully into the kind of rock, thickness of beds, and fossil remains of each of the two limestone horizons; also when one sees, at Cross Roads for example, the Cobleskill limestone on a hill but perhaps 300 feet south of a southward dipping bed of Eurypterus limestone in the bank of the stream opposite the old water mill.

In Hartnagel's article already referred to (p. 1136) he remarks regarding the condition of affairs at Thompson's quarry: "This outcrop in the cut however, is on the other limb of the anticline, with a dip strongly towards the northwest." Various pieces of rock have slid down from the top of the cut and rest at various angles, but the dip at this locality is moderate and in a southeasterly direction. The "anticline" has no real existence. The stratigraphy of the region is much more simple than this anticlinal theory would lead one to suppose. Williams clearly stated the true sequence of beds here as early as 1885. (See Amer. Jour. Sci., 3d ser., vol. 30, p. 213–214.) We are well aware of the local anticlines, synclines and domes in this region, caused mainly, we judge, by the dissolving out of lime, gypsum, and salt layers in certain localities and allowing the beds above to sink down in a very irragular manner. But there is no evidence to show that the gypsum beds about Union Springs are below the limestone so well exposed at Cayuga Junction and containing in places so

many well preserved *Eurypterus* remains. Doubtless the fact that occasionally fragments of this genus are found in the beds just beneath the Cobleskill has seemed to call for and give color to the hypothetical "anticline". But all know how *Eurypterus* may be found much lower in the Salina and much higher in the Manlius in this State.

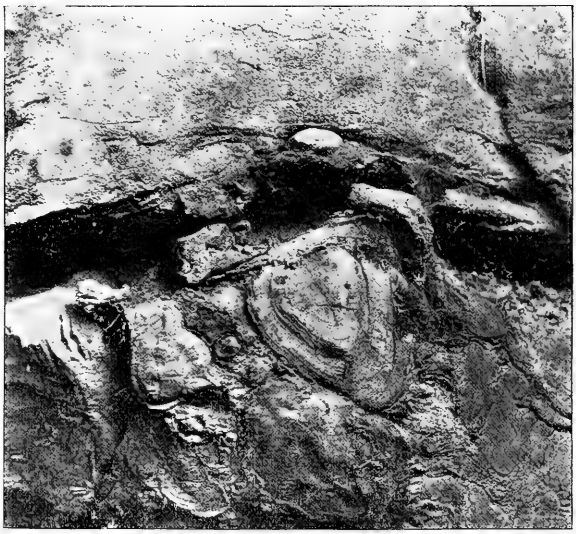
"*Salina*" *Waterlime.*—At several localities near Union Springs where the Cobleskill limestone is exposed there are shown below, layers of thin-bedded, light gray or buff colored impure limestone. Howland's Pt., north of the exposure in the woods near O'Connor's quarry, Wooley's quarry, and Thompson quarry, all show these calcareous layers, and when diligent search has been made, show practically the same fauna. They are best exposed at Thompson quarry already described. *Lingula*, *Eurypterus*, *Cyclonema*, *Modiolopsis dubius*, *Murchisonia*, *Spirifer eriensis*, *Rhynchonella agglomerata?* and *Leperditia alta* are perhaps the most characteristic forms.

Cobleskill.—The study of this stage, or substage, of the Manlius, according as we prefer to look at it, has been undertaken by Hartnagel and has been published in the Report of the State Paleontologist for 1902, and hence little attention need be given it here. Its stratigraphic relationship to other beds in this vicinity, as well as its places of outcrop can be seen by inspecting Pl. 2. The presence of *Stromatopora* in large and irregular masses gives the beds of this horizon a peculiarly rough appearance. For an exhaustive list of species occurring in these beds, see pp. 1132–33 of Hartnagel's paper.

Rondout.—Sect. 2, Pl. 3, shows fossiliferous beds above the Cobleskill which have been referred to the Rondout division of the Manlius stage. *Orthothetes interstriatus* and *Whitfieldella sulcata* are locally extremely abundant. Just what follows above these beds we have as yet found no section to show. But knowing from leveling that the vertical distance from the Cobleskill to the Oriskany is about 70 feet, and knowing the section in Union Springs from the Oriskany horizon downward for 64 feet, there can be but a very limited section not yet seen.

In the detailed section given below, we would refer the beds numbered from 9 to 18 inclusive to the Rondout. In its main features the section is repeated in Sect. No. 5, Pl. 3.

Old gypsum quarry, near Hibiscus Point on Cayuga Lake



Manlius - Onondaga Contact, Union Springs, N. Y.

Section in Union Springs by the Sanitarium

	Ft. Thick	*Total*
1. Onondaga limestone, 8 feet thick, with large corals; composed of light coarsely crystalline $CaCo^3$. Lowermost portion stained red with iron oxide and containing sand and clay iron-stones of Oriskany age	.8	.8
2. Limestone in places replete with *Stromatopora* (See Pl. 6)	2.3	3.1
3. Dove colored limestone with conchoidal fracture, apparently nonfossiliferous	2.3	5.4
4. Blue-gray, even bedded, limestone	2.9	8.3
5. Stromatopora limestone. (See Pl. 6)	4.3	12.6
6. Dark, heavy-bedded, blue limestone, with *Strophеodonta* and *Sp. vanuxemi*	6.8	19.4
7. Alternating beds of grayish and bluish limestone; beds with many fractures; often dark, cherty, breaking with conchoidal fracture. *Sp. vanuxemi*, *St. varistriata*	9.8	29.2
8. Limestone, dark at bottom, gray at top, weathering lighter. Contains a few *Sp. vanuxemi*. Opposite 4th barn in ravine	1.8	31.0
9. Dark grayish-blue limestone in broken beds; somewhat obscured by detritus	5.2	36.2
10. Dark, bluish-gray solid limestone, containing a few *Sp. vanuxemi* and forming rapids just below 3rd barn. Upper surface rough	1.8	38.0
11. Evenly bedded limestone, some layers 1ft. thick	4.0	42.0
12. Light and dark layers, shaly	.6	42.6
13. Light gray or buff colored limestone. Layers .05 to .08 feet in thickness. Shows stylolitic structure	2.3	44.9
14. Light gray to drab limestone; forming falls near 2nd barn. Contains yellowish clay nodules	3.2	48.1
15. Very light grayish-brown limestone. Notice dip, about 1-10 N. W.	4.0	52.1
16. Limestone, thick bedded	3.7	55.8
17. Thin bedded shaly limestone; layers rather irregular; forming a prominent ledge extending fully 100 ft. east of the tunnel	3.5	59.3
18. Dark and light brownish impure limestone; often irregularly bedded; in layers 1.5 ft. thick. Lowest beds seen at upper end of tunnel	5.0	64.3

As a rule, the so-called Rondout beds are much lighter in color and are far less fossiliferous than the Cobleskill below or the typical Manlius above. They seem more like the light colored

dolomitic beds of the upper Salina. Here and there *Leperditiæ* are seen, but other forms are exceedingly scarce. The basal beds already referred to as containing *Orthothetes interstriatus* and *Whitfieldella sulcata* in large numbers, it seems to us, may equally well be referred to the Cobleskill.

Manlius.—The section just given shows by beds 2 to 8 inclusive the appearance of the typical Manlius of this region. There are occasional *Stromatopora* layers just beneath the Oriskany or Onondaga as shown in Pl. 5, but generally the uppermost layers are evenly bedded and banded limestone. These beds continue for 4 ft. or so and then *Stromatopora* layers appear, as indicated on Pl. 6. In this section, as well as the one marked "5" on Plate 3, the Manlius is rather thick-bedded and very fossiliferous. *Stropheodonta varistriata* occurs in masses, and some layers contain a large number of *Spirifer vanuxemi*: *Holopea* and *Tentaculites* are of rare occurrence, while *Megambonia aviculoidea* is occasionally common.

One mile south, in the Shaliboo old quarry by the L. V. R. R. track the upper portion of the Manlius may be seen beneath the Oriskany as follows:

Section at the Shaliboo Quarry

	Ft. Thick
1. Onondaga limestone	12
2. Oriskany sandstone	¼
3. Dark, impure limestone layers	½
4. Even bedded water-lime	4
5. Thick beds with *Stromatopora*, *Sp. vanuxemi*, *St. varistriata*, *Holopea*, *Leperditia*, *Meristella*, and *Orthothetes interstriatus*	10
6. Heavy beds, dark colored, *Megambonia* and *Tentaculites*	4

These same fossiliferous beds are splendidly exposed ½ mile southeast of Thompson quarry, in a somewhat extensive limestone quarry just east of the highway. *Stropheodonta varistriata* and *Spirifer vanuxemi* are the predominant forms, though a *Meristella* (*M. lævis?*) occurs here and therewith the rarer forms. Here, as elsewhere, the Manlius often weathers a brownish color and appears rough with the fragments of crystallized stems of Crinoids. No one who has ever studied the sections north and east of Manlius could fail to see the close lithological and faunal

Manlius beds on Tunnel Creek, Union Springs, N. Y.

resemblances of the rocks at these two somewhat distant localities.

The above detailed discussion we hope will give a fairly clear idea of the occurrence of the Manlius stage at the most westerly section included in this paper. The changes, lithologic faunal and stratigraphic occurring farther east, we shall discuss in the pages which follow.

II. Split Rock

The large quarry at this locality affords a fine view of the basal beds of the Onandaga and its contact with the Manlius below. But we were somewhat disappointed in the faunal features of the last mentioned stage. The following strata were observed in a column left in the north-eastern part of the quarry where evidently a derrick had formerly been located.

Section at Split Rock Quarry.

	Ft. Thick
1. Onondaga limestone, with Oriskany pebbles at base	2
2. Light colored cement rock for 2.3 ft. then becoming gradually hard, thick bedded and blue with a few fossil fragments below	4.3
3. Hard blue bed with gray bands. *Leperditia*, small *Stromatopora* and *Spirifer vanuxemi* very abundant in layers	3.7
4. Yellowish or cement-like above; more bluish, with thin yellowish bands below. With *Sp. vanuxemi* and *Leperditia*	2.3
5. Bluish layers, very fossiliferous. Besides *Sp. vanuxemi*, these layers contain *Stropheodonta varistriata*. Middle layers with *Stromatopora*	4.8
6. As No. 5, but with less *Stromatopora*	8.3
7. Bluish gray layers with *Sp. vanuxemi*	12.0
8. Solid bluish layers, grayish above and below; often showing irregular lines of bedding. Stromatoporoid in places	5.0

From the upper 2 ft. of bed No. 2, Luther reports *Eurypterus*. (See 15th anu'l Rept. St. Geol. for 1895, p. 268.) This, we believe to be the highest horizon from which the species (presumably *remipes*) has been reported.

In the barn lot opposite the Electric R. R. station, much disturbed layers, apparently Rondout, were observed.

III Manlius.

The vicinity of Manlius has been and ever will continue to be of great interest to the student of the Salina and Manlius stages. Excellent exposures of the upper Salina may be found between Green Lakes and Manlius; and from traverse lines and lines of level we have constructed the lower part of the section given as No. 3, on Plate I. We call particular attention to this section, not because of its direct bearing upon the question of the development or extent of the Manlius fauna but to show that here, as at Cayuga, the gypsum is both over- and under-lain by Salina limestones. In other words the stratigraphy is perfectly clear in this regard, whatever doubts one may have on the subject, while studying the Cayuga section alone.

The gypsum and Cobleskill beds are seen best to the southwest of Manlius, while the layers above to the Onondaga are best seen to the east and south.

Two miles due north of Manlius, at an oblique four corners, is a small cemetery, and in its vicinity are several interesting quarries. Just west of the cemetry across the highway a new digging exposes light yellowish, gray, impure, shaly limestone layers presumably Rondout. The uppermost layers are replete with *Spirifer vanuxemi*. In beds of the same appearance and in the same horizon both in a quarry and in a small creek bed south or southeasterly about ½ mile *Eurypterus* remains are found abundantly in layers.

Manlius.—In the quarry east of the cemetery, a great change takes place towards the top of the outcrop. *Sp. vanuxemi* layers of grayish blue give place to more crystalline, rough, brown-weathering fossiliferous beds. From the cemetery, eastward to the forks of the road ¼ mile by an abandoned old stone house, these crystalline fossiliferous layers are well exposed, especially in the field to the north.

Stromatopora is seen here and there, and occasionally very abundantly, especially in the uppermost layers of this deposit.

Notwithstanding the apparent richness of the fauna of these beds, little else is found in addition to what has already been mentioned, except *Stropheodonta varistriata*, with occasional large *Megambonia aviculoidea* and a *Meristella* (*lævis?*). Still, *Tentaculites*, *Beyrichia* and *Modiolopsis dubius* have been collected from this horizon and vicinity.

In the railroad cut in the north-western part of the village of Manlius we found a *Zaphrentis*, with *Beyrichia barretti?* and *Sp. vanuxemi* in abundance.

The cement strata, as well as the rough *Stromatopora* beds, are finely displayed in the quarries on the hill just north-east of Manlius. The cement and intermediate blue limestone layers are of course to be classed as Manlius; but the *Stromatopora* and higher blue beds are less easily correlated. That the upper 10 ft., or the layers just beneath the Oriskany are Helderbergian there can be no doubt, since luckily on the hill north-east of Manlius they are often quite fossiliferous, though south-west of the village we have found no exposures where beds in this position carry Helderbergian remains. Manlius village, then seems to be in the longitude of the extreme western extension of the Helderbergian fauna. On the north-east hill, above referred to, we note *Strophеodonta planulata*, very common; *Avicula communis*, common; *Meristella lævis*, common; *Leptæna rhomboidalis*, common; a Rhynchonelloid form, *cf. R. transversa*, common; *Dalmanella oblata* and *Sp. cyclopterus?* rather rare. It may also be remarked in passing that the few inches of Oriskany sandstone at this place contains a comparatively abundant brachiopod fauna.

Detailed sections about Manlius.—Nearly all the quarries north-east of Manlius show beds down to and including the cement rock. In one place only did we find the layers exposed for a few feet immediately below. There is a quarry west of the road and ½ mile north of Manlius where about 4 ft. of blue "building stone" are seen cropping out. In the fields below, the crystalline brachiopod layers occur. What is shown on Plate I, Sect. No. 3, down to the bottom of the "16" ft. layer may be taken for a detailed section of what appears on the hills north and east of Manlius.

Section in quarry ½ mile S. of Manlius.

		Ft. Thick
1.	Upper quarry, brachiopod beds	10
2.	Unexposed	15?
3.	Gasteropod bed	2
4.	Blue-gray limestone; *Sp. vanuxemi*	4
5.	Gray, *Eurypterus*	5

South-east of Manlius, from Evergreen lake southward for a mile or more one sees fine exposures of the upper beds of the Manlius, and in many places their line of contact with the Onondaga.

Section about ¾ mile S. W. of Evergreen lake

	Ft. Thick
1. Onondaga limestone	various
2. Heavy blue layer	1.2
3. Solid layers, weathering into thin parallel layers	8.0
4. Blue limestone, Stromatoporoid in upper portion	22.0
5. Cement rock	4.0
6. Blue rock	4.0
7. Cement rock	4.0
8. Solid, blue in general, but with bands of yellow; with *Leperditia*	3.0
9. Heavy blue layers, very Stromatoporoid above and somewhat below	20.0

Extensive quarries 1½ mile S. E. of Dewitt show very plainly the relation of the Rondout stage of the Manlius to the Cobleskill and Salina beds below.

Section of quarry 1½ mile S. E. of Dewitt.

	Ft. Thick
1. Rondout limestone; cavities and chert below; grading into Cobleskill beds	20.0
2. Cobleskill *Stromatopora* layers	5.0
3. Gray, shaly limestone	1.0
4. Gray shale	1.2
5. Gray shaly limestone	3.0
6. Hard, brown dirt	1.5
7. Gypsum	35.0

Special points to be noticed in the Manlius area.—(1) The fossiliferous (brachiopod) portion of the Manlius begins with beds containing large numbers of *Sp. vanuxemi*, and this follows a *Eurypterus* fauna. (2) Here a change takes place. Sometimes the brown-weathering crystalline limestones, with great numbers of crinoidal and other fragments, come immediately upon the *Spirifer* zone. Often however, a gasteropod bed some two feet in thickness is interposed. *Stropheodonta varistriata* is the dominating species in most of these beds. *Spirifer vanuxemi* is com-

mon; *Megambonia aviculoidea*, *Meristella lævis? Tentaculites*, *Beyrichia* and *Leperditia* also occur. (3)Above the fossiliferous zone comes the well-known cement and blue limestone beds; then the ragged *Stromatopora* bed and other blue limestones, all presumably of Manlius age, though difficult to correlate owing to the lack of a characteristic fauna. Nowhere else are these so well developed. (4)The Helderbergian beds have put in an appearance and contain a fauna that is probably to be correlated with the Coeymans farther east. These beds are 10 ft. thick east of Manlius and do not appear to the south-west or west; unless one large cast of what seemed to be a *Gypidula galeata* found by Mr. Pacheco in the black, arenaceous ferruginous Oriskany, may be regarded as indicating a further extension of these beds.

IV Perryville

General section.—We have endeavored to show by Sec. 4, on Plate I how, in general, the Manlius beds occur about Perryville.

Following the creek but a few hundred feet north of the railroad station at Perryville one sees a great chasm, bordered above by Onondaga limestone beds, but exposing on either side Helderbergian and Manlius limestones. The railroad sweeps around the head of this chasm and leaves the village by going north-west instead of continuing in an easterly direction. From 1 to 1½ miles north of the station along the railway fine exposures may be seen. Upon the hills ½ mile to the east of these, other good exposures are to be found. Again, on the hill a mile west of Cottons, marked 920 on the U. S. Top. Quadrangle (Chittenango) gypsum beds with their over- and under-lying limestones occur. All these places have been visited and the general stratigraphic information obtained is shown by Sect. No. 4, Plate I.

Detailed sections about Perryville.—There is a considerable change in the appearance and thickness of the various Manlius and Helderbergian beds about Perryville and hence several sections are given herewith in detail.

Section in gorge at Perryville falls; east side

	Ft. Thick
1. Onondaga limestone	20.0

Note the overhanging appearance of the Onondaga beds, and the jogging in of the escarpment in the proximity of the Oris-

kany s. s. horizon giving the same appearance to the bluff as shown by the Coeymans and a cement bed in the Helderbergs. See Plate 9.

2.	Oriskany sandy layer	.3
3.	Helderbergian limestone	18.0

In the middle and upper portions are found: *Meristella lævis A. reticularis*, *Stropheodonta planulata*, *Spirifer vanuxemi?* var., and *Uncinulus* sp. At base occur: *Meristella lævis*, *Stropheodonta varistriata*, *Tentaculites gyracanthus*, *Beyrichia*, and a *Leptocœlia*.

4.	*Stromatopora* layer	8.0
5.	Blue layers, somewhat Stromatoporoid above with *Sp. vanuxemi*	15.0
6.	Gray limestone	4.0
7.	Blue limestone	3.0
8.	Gray and blue banded	7.5
9.	Thin blue layers	8.0
10.	Limestone more or less Stromatoporoid	3.0
11.	Thin gray limestone beds	2.5
12.	Dark, Stromatoporoid, cherty	13.0
13.	Bluish limestone	3.0
14.	Fossiliferous limestone, crinoid stems, *Leperditia*, *St. varistriata*, *Sp. vanuxemi*, *Beyrichia*, *Bythocypris*	2.5
15.	Blue limestone	7.0
16.	Solid limestone beds 1 to 2 ft. thick with *Sp. vanuxemi* occasionally. One *Meristella* observed	10.0

Section along L. V. R. R. 1—1½ miles N. of Perryville

		Ft. Thick
1.	Helderbergian fragmental limestone	13.0
2.	*Stromatopora* bed	8.0
3.	Blue limestone	1.0
4.	Blue limestone, much cracked	8.0
5.	Solid blue layers; Stromatoporoid at top	13.0
6.	Gray cement rock	3.0
7.	Blue, cracked	7.0
8.	Stromatoporoid limestone	3.0
9.	Blue limestone	1.0
10.	Gray shaly limestone	2.5
11.	Stromatoporoid limestone	15.0
12.	Dark, cracked, cherty, thin bedded limestone	15.0
13.	Crystalline and rough weathering limestone; with *Sp.*	

vanuxemi 10.0
14. Grayish waterlime? basal portion apparently gypsiferous... 21.0

Up in the fields to the east, as has been stated already, there are many fine exposures. They may be arranged in a vertical section thus:

Section in field 1½ miles N. of Perryville

	Ft. Thick
1. Onondaga limestone	20+
2. Helderbergian beds containing in places an abundance of *Gypidula galeata*	20
3. Blue, cracked limestone	10
4. Stromatoporoid limestone, with blue and cracked layers	20
5. Gray, thin bedded	7
6. Stromatoporoid limestone	4

In the vicinity of the plaster mill on the railroad 1 mile southwest of Cottons one can see highly disturbed light colored Salina limestones. In the hillside just south of the mill such a limestone forms a slight terrace beneath the pasture soil. Above it is an extensive gypsum quarry showing perhaps 25 feet of plaster rock. Above that, other limestones are seen in another opening; none however appear like typical Cobleskill.

Points of special interest in the Perryville area.—(1)The Helderbergian rocks are increasing in thickness going eastward. They are much more fossiliferous than at Manlius. They contain *Gypidula galeata*. The lower beds herein classed as Helderbergian have a decided Manlius faunal aspect.

(2)The typical Manlius beds as well as the *Stromatopora* and other beds up to the Helderbergian are much thinner than at Manlius. *Stropheodonta varistriata* is comparatively rare except in a stratum 2½ ft. thick in the Perryville Falls section.

(3)*Spirifer vanuxemi* beds here as at Manlius are just above the light colored Rondout layers.

V Oriskany Falls

We have already referred to the importance of this section in any study of the Manlius stage. Prof. S. G. Williams* remarks: "The exposure of Lower Helderberg rocks at Oriskany Falls,

*Amer. Jour. Sci., 3d Ser., 1886, vol. 31, p. 142.

eighteen miles south of Utica, is interesting, partly because it is so laid open by deep and extensive quarries as to give nearly a complete section of about 120 feet of rock, 115 of which can be definitely measured from the Oriskany sandstone, here ten feet thick, down to the bank of the abandoned Chenango canal, and partly because, while highly fossiliferous at several levels, it shows the condition and tendencies of the Lower Helderberg limestones at a point nearly midway between Schoharie County and Cayuga Lake."

The section which this author then proceeds to give, differs somewhat from the sections we have compiled at this locality for the past several seasons in connection with our Summer School of field geological work. Particularly do our thicknesses of beds vary considerably. We used a Dumpy level and rod over gentle slopes, and a steel tape wherever perpendicular escarpments were measured. He does not record his method of measurement.

Clarke remarks* in connection with his studies of the Oriskany sandstone of Becraft Mt.: "The name *Oriskany sandstone* was applied by Vanuxem to white or yellowish, often friable and crumbling quartz sandstone exposed at Oriskany Falls, Onieda Co., where it has a thickness of 20 feet. All calcareous beds are here wanting and the transition from the underlying Manlius is abrupt" etc. In view of the detailed description of this locality by Williams in 1886, giving full account of the fauna now known as Coeymans and perhaps other Helderbergian stages, we are at a loss to know the meaning of Dr. Clarke's statements. However, on p. 98 of the work just referred to, we find the following: "In east-central New York a repetition of the Manlius fauna may appear, after a brief preliminary invasion of the latter and displacing fauna, but in these oscillations between the retreating and invading faunas there is seldom evidence of a commingling of species."

From Schuchert's article† on the "Manlius Formation of New York" it appears that sections have recently been made by Dr. Clarke in this portion of the State, though we have not seen them published as yet; for Schuchert in quoting from this author says: "Neighboring sections, which we have recently

*Mem. N. Y. State Museum, vol. 3, No. 3, 1900, p. 78.

†Amer. Geol., vol. 31, 1903, p. 170.

made at Brown's Falls, Chittenango Springs, at Waterville and Oriskany Falls, show that'' etc. etc. Still later Hartnagel* in describing the section at Litchfield, Herkimer Co., says: ''The upper portion of the Manlius becomes complicated with Coeymans limestone, the faunas of these two formations either mingling or alternately recurring.''

Our observations in the vicinity of Oriskany Falls have been mainly confined to the quarries and fields to the north of the town. One may reach these fine collecting grounds by following the old Chenango canal northward for nearly a mile and then passing up and westward through field and quarries; or he may take the road to the west of the canal. This forks about ¾ of a mile out. One road then leads to Utica in a north-easterly direction, while the other continues northward over the hills. Near the forks of the road and then along either branch fine exposures are found. The lower road about a mile out from town passes over a little sluice near an old lime-kiln in the woods to the left. The old quarry nearby shows bluish-drab layers of impure limestone. Fossils are rare except *Leperditia*; but Mr. Pacheco of our party succeeded in finding recognizable fragments of *Eurypterus*, and so we have indicated the position of this bed in our general seetion No. 5, Plate I, by the word *Eurypterus*. A small outcropping of limestone layers by the roadside not far south of the sluice before mentioned yields a considerable number of small gasteropods, but their identification is difficult. They are presumably stratigraphically below the *Eurypterus* bearing horizon.

Near the lower, or Utica, road small outcrops may be seen in the fields, and, if examined they are sure to yield *Spirifer vanuxemi* in comparative abundance. Outcrops in the bank of the old canal show the same fauna. *Leperditia* too is very abundant.

The layer marked ''gasteropod bed'' is seen at the big spring from which the water issues that flows under the aforementioned sluice. In the pasture to the south, fragments of this fossiliferous layer are found quite frequently as loose boulders or rock fragments. Just beneath it are buff-colored, even-bedded cement-rock layers.

The exact thickness of the very fossiliferous portion of the

*N. Y. State Museum, Bull 69, p. 1169.

Manlius is difficult to ascertain, as it is not all exposed at one locality. The figure given (45 ft.) may be taken as only approximately correct. The lower layers are replete with crinoid stems, and *Orthis*, *Stropheodonta*, *Meristella*, *Dalmanites*, *Orthoceras*, together with *Spirifer vanuxemi* are often found in great profusion. A very detailed section of these beds has been made and a large number of fossils collected by Mr. Pacheco, but as yet the laboratory work and identification has not been completed. *Stromatopora* is abundant in layers and in weathering it gives a peculiarly rough and "corniferous" aspect to the rocks.

A little quarry has been opened up recently on the east side of the road in the gray cement rock. The floor of the quarry shows the top layers of the fossiliferous limestone. These gray rocks may be traced across the road to the large quarries west of the same, and there they form the lowest layers quarried. They show in the accompanying plate (Pl. 7) at the base of the exposure.

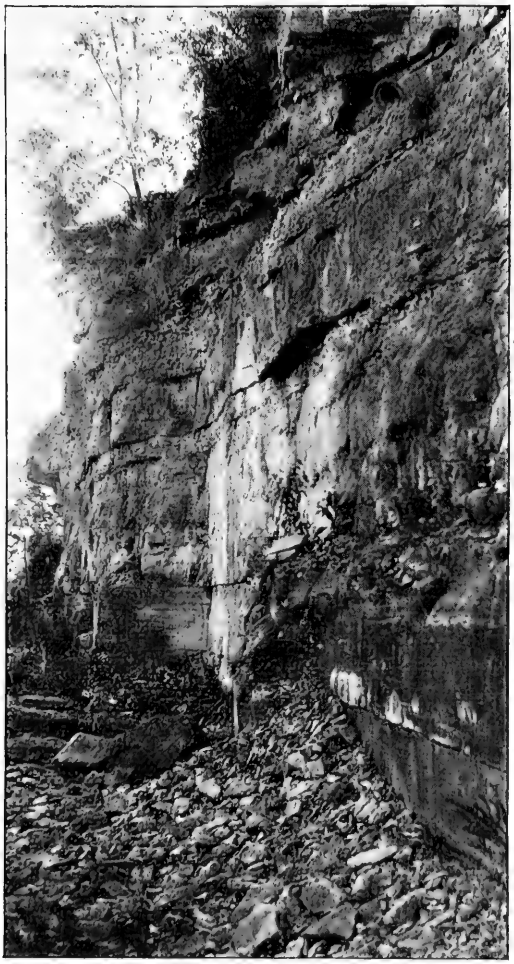
The layers which follow with a thickness of 12 ft. are of a dark, fragmental appearance, and notwithstanding the conchoidal fracture and apparent cherty character, they contain in places a goodly number of bivalves and gasteropods. They extend up to the hat shown in the plate just referred to.

Though, as Williams says, *Gypidula galeata* may be most abundant in a 1ft. layer, it really occurs through 15 ft. of typical Coeymans limestone. What follows these exposures at the quarries seems difficult to determine since in the pasture above (Mr. Allen's) the are few outcrops.

At the base of the Oriskany sandstone, layers are found replete with a *Meristella* apparently *lævis* of Hall, though Williams calls it *M. arcuata* and speaks, at least in one place, of Hall's corroboration of his identifications.

Further details regarding this section will doubtless appear in this publication a year hence.

By comparing this section with the one discussed before "IV Perryville" one notices a marked change in the thickening of the Helderberg beds, and a great increase in the number of fossils from the upper Manlius. Farther east the Helderberg beds still increase in thickness, and the Manlius retain their extreme fossiliferous character.



Quarry just west of the road leading northward from Oriskany Falls; near lower edge of Mr. Allen's pasture. Smooth cement beds below; irregular, cherty to hat; typical Coeymans above.

VI Herkimer

From four to six miles south of Herkimer the country is decidedly hilly, and quarries begin to make their appearance in several directions. First one notices the Oneida conglomorate, and the Clinton sandstones. Then he sees along the way a strip of red land, made so by the fossiliferous Clinton iron ore below. But these he passes over rapidly, likewise the Salina shales and impure limestones. Finally in the vicinity of Phil Diehl's place, the quarries and natural escarpments begin to show fossiliferous Manlius and Helderberg beds. Just before reaching this place, an exposure of buff, calcareous shale can be seen about the springs below the cider mill. Above, in the road these shales become somewhat fossiliferous ; impressions of *Sp vanuxemi* are more and more common as one goes up in the field across the road to where a slightly harder layer crops out and makes a noticeable little hillock. This is close by Diehl's house. So far, from the shale below to the outcrop in the field, there are intermittent exposures for about 50 ft.

Back of Ackler's barn, thin even-bedded *Spirifer vanuxemi* beds appear. They may be examined to advantage in the trail leading south-west from the barn. In the pasture a few hundred feet farther on in the same direction, typical Manlius beds occur with a wealth of *Sp vanuxemi*, also *Stromatopora*, *Megambonia*, and *Leperditia*.

Leaving this lot and going south-east across a small valley to where a natural escarpment forms a prominent and inviting object for investigation, one finds the upper Manlius and lower Coeymans most excellently exposed. Section 6, above the space marked "covered" was compiled at this place.

Beginning at top of talus, the rocks appear practically the same as those last discussed, typically Manlius. But as we climb up the escarpment, noting height and fossils, we see that even Oriskany Falls can scarcely furnish such a numerous sub-Helderbergian assemblage of species.

In the section, between the words "*Dalmanities*" and "*Strophheodonta*" the following forms occur: *Platyceras* (small), large coiled gasteropod, *Stroph. varistriata*, *Atrypa reticularis*, *Uncinulus nucleolata*, *Uncinulus* sp., *Sp. vanuxemi*, *Meristella lævis*, *Strophonella* sp., *Megambonia aviculoidea*, *M. spinneri*, *Tentaculites*, and a smooth *Gypidula*, more of the form and appearance of

pseudogaleata than *galeata*.

In the limestone marked "Light and dark l's," the following forms occur: *Tentaculites gyracanthus*, *Atrypa reticularis*, *Sp. vanuxemi*, *Stroph. planulata*, *Leperditia* and Trilobite fragments.

In the Stromatopora layers, in addition to this form, the following were collected: *Holopea antiqua*, *Sp. cyclopterus*, *Loxonema fitchi*, and *Leperditia*.

Above the Stromatopora bed there were perhaps 3 ft. of fossiliferous layers, but so far as observed Gypidulas were absent. The Coeymans limestone contains, among a number of other species: *Gypidula galeata*, *Strophonella punctulifera*, *Stropheodonta*, *Uncinulus*, *Meristella lævis*, *Atrypa reticularis*, *Stropheodonta becki* and a small *Platyceras*.

Here, as at Oriskany Falls, just above about 15 ft. of Coeymans there is little to be seen on account of soil covering, but here there is no question as to the presence of New Scotland beds. They are in a hill a little way back from the escarpment just described and are remarkable for the fine specimens of Spirifers, Leptænas etc., which they contain. Moreover, here is an excellent example of weather etching. The fossils stand out in relief while the limestone matrix is dissolved away.

In this neighborhood, as for example, at J. W. Humphrey's lime kiln, there are other quarries and natural outcrops, but none seemed so inviting for faunal and stratigraphic work as the escarpment at Diehl's.

VII Howe's Cave

In going eastward the Manlius again becomes less interesting faunally. The quarries back of the mills at Howe's Cave show practically the whole section. A few feet are covered on account of the railroad embankment. The Cobleskill and Salina have been studied and figured by Hartnagel. See Plate 2, of his report.

The first few feet below the Coeymans with *Gypidula*, are very fossiliferous and contain among other species: *Uncinulus mutabilis*, *Sp. vanuxemi*, *Stroph. varistriata*, *Meristella*, *Orthis*, and *Dolmanites micrurus*. But below, the great mass of fossils is made up of *Stropheodonta varistriata*, alternating with beds replete with *Tentaculites gyracanthus*. Gasteropods are in evi-

Becker's quarry in eastern part of Schoharie village, N. Y.

dence in the lowest beds of the quarry, just north of the railway track.

Schoharie.—Only about 5 miles distant from Howe's Cave are the well-known quarries of Schoharie. Clinton S. Becker's quarry in the eastern edge of the town is a good sample of these fine exposures.

Section of Becker's Q'y., Schoharie, N. Y.

	Ft. Thick
1. Helderbergian with *Gypidula*, *At. reticularis*, and many Crinoid stems and other fossil remains	15.0+
2. Transition with *Dalmanites*, and *Stropheodonta et al*	5.2
3. Blue limestone in rather thin layers (2–6 inch) showing irregular bedding planes, and often separated from the next higher layers by a 3 inch shaly layer that is easily weathered out. The surfaces of thin layers are literally covered with *Sp. vanuxemi*, *Tentaculites gyracantheus*, *Leperditia* and *Stropheodonta varistriata*. Gasteropods and *Orthoceras* are not rare. The edges of the thicker layers, upon weathering show the brownish, rough appearance, with *Stroph. varistriata* cross-sections mentioned in our discussion of the Union Springs and Manlius sections	8.5
4. Fairly solid layers, with many *Leperditia*	2.8
5. Solid blue bed; fossil lamellibranchs	2.0
6. Black, shaly limestone, with *Sp. vanuxemi* in great abundance	4.5
7. Solid blue bed	2.6
8. Rather thin-bedded layers, with occasional *Stromatoporæ* about 1 ft. from top of bed; *Tentaculites* very abundant on surface of some layers	8.4
9. Heavy blue beds, with *Leperditia*, *Sp. vanuxemi* and *Tentaculites*	4.7
10. Heavy blue bed, fossils as in No. 9	2.6
11. Floor of quarry of shaly, calcareous, gray, mud-cracked, thin layers.	

The transition from solid to somewhat alternating wavy layers is well shown in the accompanying plate, from a photograph by Mr. J. L. Rich of our company. The heavy basal beds, 9 and 10 of our section, are evident. The uppermost central portion shows Coeymans layers; but as the section was not made at the particular place photographed, it is difficult to locate the desribed beds in the photograph accurately.

Five miles east of Schoharie, in the vicinity of Gallupville, excellent exposures are seen in the pasture lot south of the Berne road. So far as could be judged from a hasty inspection, the Manlius beds here resemble their westward extension at Schoharie and Howe's Cave.

Summing up the general characteristics of the Manlius in the Schoharie region we note: (1) The decrease in number of specimens of brachiopods in the upper portion of the stage, save the very top layer, which we have called "transition" and may as well be referred to the Coeymans. (2) The *Strophеodonta* layers become again very noticeable, resembling their equivalents in the Manlius and Union Springs sections. (3) *Tentaculites gyracanthus* begins to make its appearance in great numbers, especially in the thin, gray, shaly laminæ. (4) *Stromatopora*, though present in several layers does not appear prominently in any. In fact its presence would often scarcely be suspected unless a special search were made for it. (5) The sum total thickness of the Manlius stage, including the Rondout and Cobleskill substages, is materially decreasing eastward.

VIII Helderbergs

General section.—The general section presented as No. 8, Pl. 1, is based largely on the outcrops near Indian Ladder. Especially is this true of the few feet at base, including the Hudson River shales and sandstones.

Special sections.—The Altamont—Thompson's Lake road about 2 miles south of the former locality, passes over the northern edge of the Helderberg escarpment. Old quarries by the wayside reveal more or less complete sections of the Manlius stage. Just west of the road we note:

Section 2 miles south of Altamont

	Ft. Thick
1. A transition brachiopod fauna in a Stromatoporoid limestone	5.7
2. Blue limestone with Gasteropods	3.0
3. *Stromatopora* in limestone	2.5
4. Buff-colored impure limestone	5.0
5. Hard blue limestone with *Tentaculites*, *Leperditia*, and *Sp. vanuxemi*	8.3

East of the road, behind a barn we note:

		Ft. Thick
1.	Coeymans	15+
2.	Transition beds	2
3.	Rough, Stromatopora bed	8
4.	Blue, shaly limestone	2
5.	Covered	3
6.	Shaly	2
7.	Cement rock	2
8.	Hard blue	3
9.	Blue, shaly	1
10.	Hard blue	4
11.	Blue, shaly	1
12.	Hard limestone	2
13.	Covered	28

Just below this covered zone the Hudson River beds crop out. Springs are numerous along this line of contact.

Farther east, near the base of the escarpment where the first spring west of Indian Ladder flows from under the rocks, we measured the following section.

Section ¼ mile W. of Indian Ladder, (below the Coeymans limestone).

		Ft. Thick
1.	Transition layers	2.0
2.	Blue limestone	.6
3.	Stromatopora bed	3.1
4.	Blue limestone beds	6.0
5.	Buff, shaly, or cement beds	3.0
6.	Stromatopora beds	9.0
7.	Blue limestone, thick and thin layers	32.9
8.	Gypsum	1.5
9.	Gray, shaly layers	.5
10.	Hudson River s. s. and shale	

At the "ladder" or only a few hundred feet to the west there is a better exposure of the basal beds represented in the last section. In fact there are four or five feet of gypsiferous and pyritiferous shales, resembling in many ways the Salina beds beneath the Cobleskill at Howe's Cave.

Countryman Hill Section, lower escarpment

		Ft. Thick
1.	Coeymans limestone	32.0
2.	Brachiopod transition layers	2.5
3.	Blue limestone	1.0
4.	Stromatopora bed, with gasteropods at base	3.2
5.	Solid blue layers	4.8
6.	Light buff cement rock	3.3
7.	Limestone layers, irregular above Stromatoporoid below	9.0
8.	Blue limestone	1.3
9.	Thin, even-bedded layers	6.0
10.	Even-bedded, thicker layers; *Leperditia*, and *Sp. vanuxemi*	6.0
11.	Dark blue and gray limestone, rather thin-bedded, with *Stroph. varistriata*, *Sp. vanuxemi*, *Megambonia aviculoidea*, *Orthoceras*, *Leperditia and Tentaculites gyracanthus*	16.0

General Resume

1. In the upper portion of the Manlius stage (that represented between the dotted lines on Pl. I) there is a rich brachiopod fauna. This is preceded or introduced by a comparative large number of *Spirifer vanuxemi.*

2. Whereas the number of individuals in this fauna may be as great in sections towards Union Springs and the Helderbergs as intermediately, the number of species and genera increases in a most remarkable way in the intermediate sections.

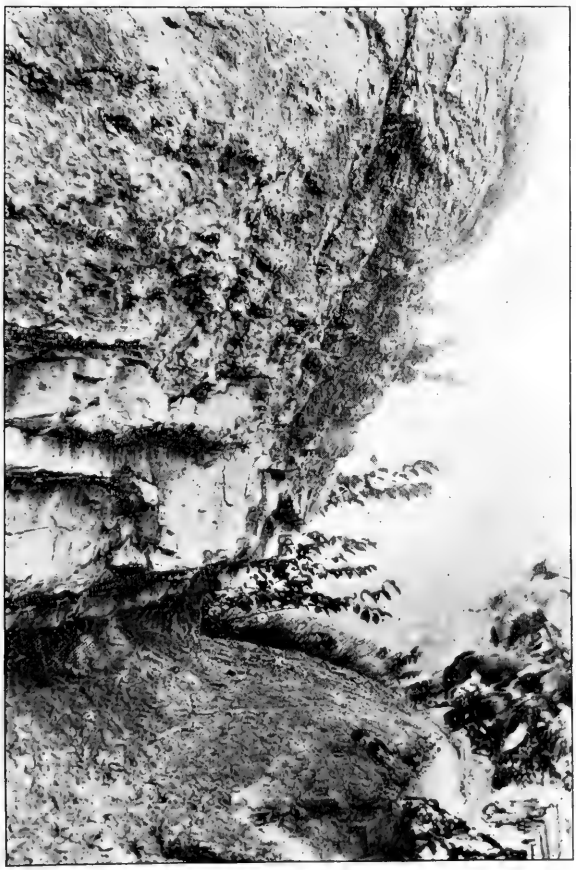
3. The new species introduced into this Manlius horizon are all of Helderbergian type, though the most characteristic Coeymans brachiopod, *Gypidula galeata* seems to be wanting

4. This fauna is usually separated from the true Helderbergian beds by (1) a stratum of buff colored limestone (see Pl. 9) resembling the cement layers at Manlius, or (2) by solid limestone layers with an abundance of *Stromatopora*, or (3) by both.

5. The greatest development of beds mentioned under "4", is found in the region of Manlius.

6. So far as we have observed, the so-called Manlius fauna does not recur after the appearance of *Gypidula galeata.*

7. There seems, then, not to be a hopeless intermingling of Helderbergian and Manlius faunas. Some regions were more



Eastern escarpment of the Helderbergs, Countryman Hill section; showing deeply eroded cement bed about 10 feet below the base of the Coeymans

favorable for engendering a diversified fauna than others. A fauna, so engendered, subsequently to become the Coeymans, invaded the Oriskany Falls—Howe's Cave portion of the region under consideration (see Pl. 1.) Farther east and west the older, Manlius type of life held on, and oftentimes luxuriated in a most unprecedented manner.

8. In the Helderberg region *Tentaculites* are rare above the lower 25 ft. of the Manlius. They appear in great force in layers as far west as Howe's Cave. Though rare, they may be expected in any Manlius horizon farther west.

9. Near the base of the fossiliferous zone under consideration, there is often a bed replete with gasteropods. The same is true of the Stromatopora layers, not far below the Coeymans.

10. Incidentally we have indicated: (*a*) the westernmost extension of the Helderberg beds; (*b*) their rate of thickening eastward; (*c*) their exact thickness at Countryman Hill; (*d*) the great extent of exposures north of Manlius, down almost to the red Salina beds; and (*e*) the true stratigraphy of the gypsum and over- and under-lying limestones about Union Springs.

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No. 20

THE FAUNA AND STRATIGRAPHY OF THE JEFFERSON LIMESTONE IN THE NORTHERN ROCKY MOUNTAIN REGION

BY

E. M. KINDLE

June 5, 1908

Cornell Univ., Ithaca, N. Y.
U. S. A.
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THE FAUNA AND STRATIGRAPHY OF THE JEFFERSON LIMESTONE IN THE NORTHERN ROCKY MOUNTAIN REGION*

BY

EDWARD M. KINDLE

CONTENTS

INTRODUCTION

The considerable thickness of the Jefferson limestone in Montana, in many places approaching 1000 feet, together with its rather wide distribution gives the formation an important rôle in the areal geology of Montana and adjacent states to the south. Its importance as a mountain-making formation is perhaps next to that of the Madison limestone in the Paleozoic of the northern Rocky Mountain region. Owing to the scarcity of fossils in it our knowledge of the age of this formation has remained very scanty and uncertain.

The principal objects of the field work on the Jefferson limestone were to determine the age of the formation and to get a general conception of its extent and a knowledge of the fauna

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characterizing it. The first of these has been accomplished and the data on which the place of the formation in the time scale is based are presented in this paper. Only a beginning has been made on the other two subjects of investigation, but the results are believed to be of sufficient interest to geologists engaged with the stratigraphic and faunal problems of the northern Rocky Mountain region to justify bringing them together in this paper. The observations of the writer show that the Jefferson limestone extends some 250 miles south of the previously known area of its development in Montana.

The rather meager fauna which is described represents an area and conditions which generally must have been very unfavorable to life, the greater part of the beds in most sections being barren of fossils. Most of the fossils listed have been obtained at a few localities where the conditions of life and of fossilization were exceptionally good. The discovery of other such exceptional sections in the future may be expected to add many species to the fauna.

NOMENCLATURE

The Jefferson limestone is well exposed near Threeforks, Montana, a few miles above the mouth of the Jefferson River, from which its name is derived. The formation, as defined by A. C. Peale[1], who introduced the name, comprises a series of magnesian limestones 640 feet in thickness, resting upon a pebbly limestone provisionally referred to the Cambrian, and terminated above by the Threeforks shale[2], which carries a rich Devonian fauna. The Jefferson limestones are described by Peale as "brown and blackish in color and microgranular in structure, due to their being very crystalline, and occur in alternations of rather massive beds of very dark limestones, from

[1]Bull. U. S. Geol. Survey, No. 110, 1893, p. 27.

[2]The Threeforks shale generally contains some calcareous beds. At Logan near the type locality 10 feet of limestone occupies the middle of the formation. Where the limestone element predominates over the shale this formation has been called the Threeforks limestone as in Geol. Atlas U. S., Folios Nos. 30 and 52.

10 to 15 feet in thickness, with lighter-colored, more laminated lime stones in layers of 2 feet to 5 or 6 feet each.

This limestone shows a striking uniformity over a wide area, not only in its dark chocolate-brown or almost black color, but also in chemical composition, as shown by Peale. Weed's characterization of the formation as it appears 75 miles north of Threeforks, as comprising "chocolate-brown or steel-gray crystalline limestones, generally having a distinctly granular or saccharoidal texture, which is especially noticeable in weathered surfaces,"[3] would apply equally well to many sections exposed in the vicinity of the type locality.

The Threeforks shales, which separate the Jefferson from the Madison limestone at Threeforks, are in many places absent from the section. Where this is the case the line between the two limestones is usually indicated by the contrast in color and composition, the Madison being much lighter in color than the Jefferson and nonmagnesian.

The comparative uniformity of the lithologic features of the Jefferson limestone over a considerable area has enabled geologists to discriminate the formation in each of the published Montana folios that include the Devonian, as well as in the Yellowstone Park and Absaroka folios.

In the Little Belt Mountains quadrangle the Jefferson limestone is "a distinct stratigraphic unit" according to Weed, but for cartographic reasons it is united with the Threeforks formation and called the Monarch formation in the folio[4].

The faunal contents of the Jefferson formation are generally very meager. The collections which have been made heretofore have been insufficient to determine with any degree of certainty the age of the formation.

AREAL DISTRIBUTION AND STRATIGRAPHIC DETAILS

Extent of formation.—The Jefferson limestone has a wide distribution in the northern Rocky Mountain region. In Montana

[3]Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p.288.

[4]Geologic Atlas U. S., folio 56, U. S. Geol. Survey, 1899, p. 2.

its distribution seems generally to coincide with that of the Madison limestone, which immediately follows it in the sections where the highest formation of the Devonian system is absent. Its distinctive composition and color have enabled geologists to identify the Jefferson limestone over a rather wide area in Montana and northwestern Wyoming. The writer has recognized the formation still farther south in western Wyoming and northeastern Utah.

Our information concerning the areal limits of the formation relates mainly to its northern and eastern extent. The most westerly section which has been studied is in the Philipsburg quadrangle. Here the formation has about its maximum thickness, which would indicate that it probably extended considerably farther westward. In northwestern Montana the formation is absent, according to Willis, who reports that the Carboniferous limestone rests upon the Algonkian[5]. In the Fort Benton quadrangle, in the north-central part of the State, the formation has thinned to about 100 feet, according to Weed[6]. The greatly reduced thickness here would indicate that the formation probably has no great extent northeast of Fort Benton. In Wyoming the eastern boundary of the formation can be stated within rather broad limits. Hague recognizes the formation in the Absaroka quadrangle, but in the Bighorn Mountains, just east of this quadrangle, Darton finds the Carboniferous limestone resting upon the Ordovician and the Jefferson formation absent. In the southern part of Wyoming the writer has studied two sections of the Paleozoic rocks, oriented in an east-west direction not far from the forty-second parallel. The more westerly of these sections is that at Labarge Mountain, about 35 miles east of the Idaho line. The Jefferson limestone is represented by about 1,000 feet of drab to black magnesian limestones in this section, resting upon rocks of Cambrian or later age. The other section is located near Raw-

[5]Bull. Geol. Soc. Am., vol. 13, 1902, pp. 316–325.
[6]Folio 1, U. S. Geol. Survey, 1899, p. 2.

lins, about 160 miles east of Labarge Mountain. Here the Jefferson limestone is absent. The interval between the Cambrian quartzite and the Carboniferous is occupied by a hard gray nonmagnesian limestone about 180 feet in thickness, of undetermined age, but clearly a different formation from the Jefferson. From the foregoing it appears that the eastern border of the area in which the Jefferson limestone is known to occur would be defined by a north-south line crossing the western half of the State between the Absarokas and the Bighorn Mountains, in the northern part, and the towns of Kemmerer and Rawlins, in the southern part. Sections studied by the writer in the Wasatch Mountains of northeastern Utah, near Logan, show that the Jefferson is present there, with the same physical characteristics which it shows in western Montana. The formation probably did not extend eastward into Colorado; at least not as far east as the Glenwood section, where the Devonian is represented by a very different type of limestone which holds a fauna quite different from that of the Jefferson limestone. All the Colorado sections which have been studied show the Devonian, where present, to be represented by a formation which is distinctly different, both lithologically and faunally, from the Jefferson limestone.

The evidence now at hand indicates that the eastern edge of the formation lies somewhere near the 109th parallel in the States of Montana, Wyoming, and northern Utah. What its southern and western limits may be remains to be determined. The formation has a known east-west extent of about 150 miles in Montana and a north-south extent of about 425 miles. Its actual extent is probably much greater. The paleontologic evidence of the identity of this formation with the Nevada limestone of Nevada is presented elsewhere in this paper.

Sections in Montana.—Some of the stratigraphic evidence on which the extent of the Jefferson limestone as outlined above is based may be shown by consideration of a few typical sections which include this formation and exhibit its relations. The section at Threeforks, Montana, the type locality of the Jefferson, as given by Peale, is as follows:

Section at Threeforks, Montana

			Feet	Feet
Carboniferous	Madison limestone	575 Jaspery limestones 350 Massive limestones 325 Laminated limestones		1250
Devonian	Threeforks shales	70 Upper Shales (Limestone bed shown in section) 65 Lower shales		135
Silurian (?)	Jefferson limestones	640 Black limestones		640
Cambrian	Gallatin formation	145 Pebbly limestones 30 Dry Creek shales 260 Mottled limestones 280 Obolella shales 120 Trilobite limestone		835

The composition of the Threeforks shale, which separates the Jefferson limestone from the Madison, is shown in the following detailed section of these beds taken opposite Logan:

Section of Threeforks shales at Logan, Montana

		Feet
E.	Buff or yellowish calcareous sandstone, becoming a shale in lower half	30
D.	Gray limestone and shale	5
C.	Green argillaceous shale, with limestone concretions and an abundant fauna	50
B.	Gray limestone, buffish at base	10
A.	Buff, locally reddish, sandy shale, with shaly yellow limestone near top	45
		140

The limestone separating the Upper and Lower shales of Peale's section is represented by B of the Logan section. Through the expansion of this bed or the interpolation of others the Threeforks shale sometimes becomes more of a limestone than a shale formation which has led to the use of the name Threeforks limestone instead of Threeforks shale in some of the publications of the Survey.

While the Jefferson limestone is generally nearly black or dark chocolate colored, beds of mottled buffish color are in places

interpolated in the darker beds. A band of dark red shale about 40 feet thick occurs about 120 feet below the top of the formation north of Logan.

Fossils are rare in the formation about Logan. The collection made here is limited to a small coral of undetermined species, *Schuchertella chemungensis* cf. *arctostriatus*, and fragments of fish teeth.

The Threeforks shales appear to have a much more limited distribution than the Jefferson limestone. They are present, however, in the Melrose section, on Camp Creek, some 30 miles west of Threeforks. The following section is seen along Camp Creek:

Section on Camp Creek, Montana

K.	Gray nonmagnesian limestone (Madison limestone)	300+
J.	Bluish gray argillaceous shale, buffish shale in lower part, with limestone bands near middle (Threeforks shale)	200±
I.	Black magnesian limestone, with minor beds of gray limestone distributed through the series (Jefferson limestone) ..	500±
H.	Buff-gray, hard magnesian limestone, with some shaly bands.	30
G.	Buffish gray nonmagnesian limestone in 1-inch to 3-inch laminæ, separated by thin bands of shale	35
F.	Dark-red sandy shales	20
E.	Light-gray magnesian limestone, with some dark bands in lower half	500±
D.	Shale	100
C.	Shale and thin-bedded brownish sandstone	50
B.	Gray shale	40
A	Quartzite weathering brownish buff	65

The Jefferson limestone seems to reach its maximum thickness in the western part of the State. In the Philipsburg nearly 1,000 feet of the Paleozoic section is represented by the dark limestones of the Jefferson formation. The following section indicates the relationship of these beds in this region, as seen along Boulder Creek, west of Princeton.

Section along Boulder Creek, Philipsburg quadrangle, Montana

		Feet
E.	Dark-gray to white heavy-bedded and flaggy limestone, shaly toward the base (Madison limestone)	500+
D.	Gray to black limestone in alternating beds, the latter predominating and distinctly magnesian, generally with saccharoidal texture (Jefferson limestone)	800
C.	Gray to brownish shale and sandstone, the latter predominate at the base	210
B.	Bluish gray limestone, with thin siliceous, argillaceous and shale films at intervals of 1 inch to 3 inches. These intermediate laminæ weather brownish and show in relief thin, flat, pebble-like concretionary (?) sheets	275
A.	Light-gray to cream-colored, hard magnesian limestone	300

This section differs from the two preceding sections in the absence of the Threeforks shale, which seems to be everywhere wanting in the Philipsburg quadrangle. About 200 feet below the base of the dark limestone series a limestone of very peculiar lithologic characteristics (B of the section) is present, which carries a fauna that was referred to Mr. E. O. Ulrich and reported by him to represent a horizon "about basal part of Upper Cambrian or near top of Middle Cambrian." Bed G of the Melrose section is readily recognizable by the same lithologic peculiarities, although no fossils were obtained. The "pebbly limestones" of Peale's section probably represent the same formation in the Threeforks section.

No fossils were procured from the 200 feet of beds at the base of the Jefferson limestone, so that the age of the beds intervening between the Cambrian and Devonian faunas remains undetermined in this region. No evidence of any stratigraphic break in this part of the section was observed.

The following fossils represent the fauna which occurs in the less magnesian bands of the middle and upper half of the Jefferson limestone in the Boulder Creek section:

Fossils from section 2½ miles northwest of Princeton, Montana (*16 c*)

Favosites cf. *limitaris*
Productella cf. *subaculeata*
Schuchertella chemungensis var. *arctostriata*

Hypothyris globularis n. sp.
Atrypa missouriensis
A. reticularis
Athyris parvula
A. montanensis n. sp.
Spirifer occidentalis n. sp.
S. engelmanni
S. argentarius
S. utahensis
Loxonema approximatum?
Straparollus sp.

About 20 miles south of Princeton, on the east fork of Rock Creek, nearly the entire thickness of the Jefferson limestone is exposed. The lower 300 feet of the Madison limestone in this section is more or less shaly. The contact of the Jefferson limestone and the overlying formation is not exposed in the Rock Creek section. The beds immediately below the dark limestones of the Jefferson formation as seen in the Rock Creek gorge are given in the section following:

Section on East Fork of Rock Creek, Montana

		Feet
E.	Shales and covered	30
D.	White limestone	5
C.	Brownish arenaceous thin-bedded magnesian limestone	90
B.	Limestone banded with thin wavy laminæ of brown to gray shale, the latter usually in ½-inch bands interbedded with gray limestone in 2-inch to 3-inch strata	250
A.	White magnesian limestone	225

The peculiar laminated limestone (B of the section) contains a fauna in which trilobite fragments are abundant. This limestone has the same lithologic and faunal characteristics as division B of the Boulder Creek section. The fauna of these beds is identical with that occurring in B of the Boulder Creek section and represents basal Upper Cambrian or late Middle Cambrian, according to Mr. E. O. Ulrich, who examined the collection made by the writer.

No fossils were obtained from the beds separating this formation from the Jefferson in either the Rock Creek or Boulder Creek sections. These beds, measuring 210 feet in thickness in the Boulder Creek section and 125 feet in the Rock Creek section may provisionally be referred to the Silurian.

From the lower 50 feet of the Jefferson limestone in the Rock Creek section the following fossils were found:

Schuchertella chemungensis var. *arctostriata*
Stropheodonta cf. *macrostriata*
Spirifer engelmanni

Other sections in southwestern Montana might be given which would present the same general sequence with reference to the Jefferson limestone. All the sections show a limestone series in which dark to nearly black limestones predominate, followed by the Madison limestone, which is locally separated from the Jefferson by the Threeforks formation. The Jefferson in all the Montana sections is preceded by limestones and shales in which the latest observed faunas are of Cambrian age.

Sections in Wyoming.—The Montana sections show a close correspondence in these characteristic features to the southwestern Wyoming section, which follows. This section occurs in the westward-dipping beds of Labarge Mountain, northeast of Viola post office and west of the Sayles coal mine.

Section Northeast of Viola, Wyoming

J.	Light to dark-gray limestone, oolitic in lower 20 feet (Madison limestone)	500±
I.	Drab shales and shaly, thin-bedded magnesian and siliceous limestone	80
H.	Buff to gray, limestone with much black magnesian limestone in the upper part, saccharoidal in texture, and weathering with roughly pitted surface; covered in part (Jefferson limestone)	1000±
G.	Gray limestone, partly covered	700±
F.	Gray limestone, with Cambrian trilobites abundant	40
E.	Green shale and covered	300±
D.	Drab shale and covered	30
C.	Thin-bedded gray limestone, with Cambrian trilobites	

	abundant	10
B.	Drab shale, mostly covered	100
A.	Lead-gray limestone, checked by innumerable small joints which are generally calcite filled	120

In this section the gray and black limestone series is preceded by beds holding a Cambrian fauna and followed by a limestone holding the usual Madison limestone fauna. The shale formation (I) at the top of the magnesian limestone formation appears to occupy the position of the Threeforks shale, but it is barren of fossils. Composition, texture, manner of weathering, and relationship to the section all indicate that the magnesian limestone series of the section is the same formation as the Jefferson limestone of the Montana sections.

The Jefferson limestone of the Labarge Mountain section is nearly barren of fossils. The only fossils obtained in it were *Zaphrentis* and fragments of another undetermined coral. The gray limestone (C and F of the section) contains a fauna which Mr. E. O. Ulrich reports to be of late Middle or basal Upper Cambrian age[7].

We are without positive information regarding the age of the 700 feet of gray limestones below the saccharoidal limestones of the Jefferson. These beds (G of the section) may be in part of the same formation and age as the 40 feet of limestone at their base, the age of which is known by its fossils to be Cambrian. It seems probable, however, that Silurian or Ordovician strata or perhaps both may be included in the series. The Ordovician is present in the Bighorn Mountains to the north, and both are present in northeastern Utah.

The Carboniferous limestones which comprise the two uppermost divisions of the section contain a fauna representing the Madison limestone fauna of Montana and Wyoming. Fossils collected from the lower 100 feet of the beds marked J have been determined by Dr. G. H. Girty as follows:

Menophyllum excavatum
Rhipidomella pulchella

[7]Letter to the writer dated February 11, 1908.

Schuchertella inflata
Spirifer centronatus
Martinia rostrata
Spiriferina solidirostris
Composita humilis
Camarotœchia metallica
Camarotœchia aff. *sappho.*
Composita immatura
Cleiothyridina aff. *hirsuta*
Eumetria verneuiliana

Devonian Rocks in Idaho.—The only data we have relating to the Devonian in Idaho are based on a small collection of fossils made by Mr. F. B. Weeks during the summer of 1907. This collection was procured from a dark limestone "in southeastern Idaho, east of Manson station, Oregon Short Line Railroad." The three species represented in the collection are *Atrypa reticularis*, *Productella* cf. *subaculeata*, and *Spirifer disjunctus* cf. var. *animasensis*. The first species is the most abundant in the fauna. The presence of *Sp. disjunctus* seems to indicate an Upper Devonian horizon. The fauna is not sufficient to show whether or not the Jefferson limestone is represented by it. Probably, however, it is from this formation. The appearance of the rock, which is a dark, somewhat magnesian limestone, is highly suggestive of the Jefferson limestone. The evidence of the small fauna, though inconclusive, points to the Jefferson limestone rather than to the Threeforks shale as its source.

About 60 miles southeast of this locality in northeastern Utah, the Jefferson limestone is well developed.

Sections in Utah.—Field studies in Utah were limited to the northern part of the Wasatch Mountains. Numerous excellent sections of the Paleozoic are exposed by the deep canyons east of Cache Valley. The canyons cut at right angles the general trend of the structure, which is of the moderately folded type, few of the heavier dips exceeding 30°. Nearly vertical cliffs 2000 feet or more in height alternate with slopes of every degree of inclination along the sides of the canyons.

Mr. Arnold Hague, who as a member of the Fortieth Parallel Survey appears to have been the first geologist to visit these canyons, describes briefly the section in Blacksmith Fork Canyon. To the scenery of the bold canyon walls Hague very justly pays the superlative compliment that it is the most beautiful "to be found within the limits of this Survey[8]." In describing the Blacksmith Fork section Hague refers to two formations[9] the beds studied by the writer. These in descending order, are the Wasatch limestone, the Ogden quartzite. The last term probably includes the beds lying at the base of the section studied by the writer, or the Ordovician of our present classification. The names Ogden quartzite and Wasatch limestone were both based on sections exposed between Ogden and Salt Lake City, considerably south of this region. The Ogden quartzite as applied by Hague may also have included the white magnesian limestone of the writer's section, which locally is highly siliceous and contains a Silurian fauna[10]. The Jefferson limestone with which the writer correlates the dark magnesian limestone above the Silurian horizon evidently represents only a portion, and presumably the lower portion of the "Wasatch limestone." In introducing the term "Wasatch limestone" King[11] made no attempt to separate the Carboniferous and Devonian horizons and states that the formation includes a limestone series 5000 to 6000 feet thick which ranges from Devonian to Coal Measures in age[12]. The extreme comprehensiveness of the term Wahsatch limestone would preclude its use in the more detailed work of the present time, even if it had not been made unavailable by the well established use of "Wasatch formation" for Eocene rocks in the same general area.

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[8]Rept. Geol. Expl. 40th Par. 1877 p. 408.

[9] " " " " " " p. 408.

[10]Kindle, E. M., Occurrence of the Silurian fauna in western America Am. Jour. Sci., vol. 25, 1908, p. 127.

[11]Am. Jour. Sci., 3d ser., vol. 11, 1876, p. 478.

[12]Rept. Geol. Expl. 40th Par., vol. 1, 1878.

Examination of half a dozen of the canyon sections to the south of Logan Canyon has shown that the Carboniferous and Devonian portions of the section may be distinguished both by physical and faunal characters. In the Devonian series, generally 1000 to 1200 feet thick, dark magnesian limestones are the predominant element, although nonmagnesian limestones and in some places argillaceous rocks appear as minor components of the formation. In the Carboniferous the dark magnesian limestones of the lower series are replaced by lighter-colored nonmagnesian limestones. The Carboniferous and Devonian series of these sections show about the same kind and degree of contrast which is found between these series in the Montana section. The Devonian beds of these northern Utah sections appear without question to be the southern continuation of the Jefferson limestone. The following is a representative section occurring nearly east of Paradise Post Office, in Green Canyon.

Section in Green Canyon, Utah

		Feet.
D.	Gray nonmagnesian limestone, partly covered	900 ±
C.	Dark-gray to black magnesian limestone, generally with saccharoidal texture	1100 ±
B.	Thin-bedded limestone, buff or brownish near top, with peculiar concretionary development, with thin-bedded bluish-gray limestone in lower part	100
A.	White to light-gray magnesian limestone, with chert or siliceous beds locally developed	150
		2250

The dark magnesian limestone (C) seems clearly to correlate with the Jefferson limestone of Montana. The following is a list of species obtained from these beds in the Green Canyon section:

Fossils from Green Canyon, Utah

Productella spinulicosta
Camarotœchia sp.
Spirifer argentarius

Leiorhynchus utahensis n. sp.
Spirifer disjunctus var. *animasensis*
Pterinopecten sp.
Actinopteria sp.
Cytherella sp.

A collection of fossils from the Carboniferous limestone (D) was referred to Dr. Girty, who reports it to represent a fauna of early Mississippian age. The following species were identified by Dr. Girty:

Menophyllum sp.
Chonetes logani
Productus laevicosta
P. aff. *scabriculus*
Spirifer centronatus
S. striatus var. *madisonensis*
Cleiothyridina crassicardinalis?
Proetus peroccidens
Cypricardinia scitula?

Below the Jefferson limestones in the white limestone (A of the section) the following fauna was procured:

Favosites gothlandicus
F. cf. *niagarensis*
Halysites catenulatus
Zaphrentis sp.
Pentamerus oblongus

This fauna, though containing a small number of species, is represented by a great number of individuals. *Pentamerus oblongus* is the most abundant species. The presence of this brachiopod, which is one of the most common and widely distributed Silurian species in the Eastern States, places the Silurian age of this fauna beyond question.

One of these species, *H. catenulatus*, ranges upward into the dark limestones, where it is not uncommon in both Green Canyon and Logan Canyon. It does not occur in precisely the same strata as the Devonian fossils, so far as observed. The latter are nearly always found in nonmagnesian beds which occur at inter-

vals in the nonmagnesian series, whereas the *Halysites* is found in the most highly magnesian beds of the series. It was clearly contemporaneous with the Devonian fauna. In the Logan section *H. catenulatus* occurs above beds holding the following species:

Favosites cf. *limitaris*
Martinia maia
Pleurotomaria sp.
Naticopsis sp.
Tropidocyclas sp.
Spirorbis sp.

The presence of *M. maia*, which is by far the most abundant species in this faunule, indicates clearly that a Devonian horizon is represented.

Correlation

Previous correlations.—Owing to the extreme scarcity of fossils which generally characterizes the Jefferson limestone, all the references to the age of the formation which occur in the literature are either largely provisional or purely hypothetical. In five of the papers in which the formation is discussed it is referred to the Silurian[13]; in three others it is called Devonian[14]; and in two others, including the most recent reference[15], these beds are placed in a Devono-Silurian series[16].

Only two of these papers contain paleontologic data regarding the age of the beds. Peale[17] obtained Devonian fossils about 30

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[13]Weed, Geologic Atlas U. S., folio 30, U. S. Geol. Survey, 1896, Weed and Pirsson, Bull. U. S. Geol. Survey No. 139, 1896, p. 37. Weed. eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 469–470. Hague, Geologic Atlas U. S., folio 52, U.S. Geol. Survey, 1899, p. 2. Iddings and Weed, Mon. U. S. Geol. Survey, vol. 32, pt. 2, 1899, pp. 1–164.

[14]Peale, Bull. U. S. Geol. Survey No. 110, 1893, p. 27. Weed, Geologic Atlas U. S., folio 1, U. S. Geol. Survey, 1894, p. 2. Peale, Geologic Atlas U. S., folio 24, U. S. Geol. Survey, 1896.

[15]Emmons, Bull. U. S. Geol. Survey No. 315, 1907, p. 34.

[16]Weed, twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 287.

[17]Bull. U. S. Geol. Survey No. 110, 1893, p. 29.

feet below the top of the formation at Threeforks, which were determined as follows:

Spirifer disjuncta
Chonetes macrostriata
Smithia? sp. undetermined
Orthis sp. undetermined

Concerning the several hundred feet below the horizon of this fauna Peale was able to offer no evidence.

Weed procured two small lots of corals in the Little Belt Mountains[18]. One of these was reported by Schuchert to contain *Diphyphyllum cæspitosum* Hall, which was regarded by him to represent a Silurian horizon. The other lot, which Girty considered of Devonian age, contained *Stromatopora*, *Pachyphyllum* (near *woodmani* H. & W.) and *Acervularia*.

Considering the poor state of preservation of the corals as generally found in this formation, the conflicting opinions based on this class of fossils are not surprising.

Weed[19] also records Girty's report on a collection of fossils from Philipsburg which is said to be of Devonian age. Through the courtesy of Dr. Girty an interpretation of this faunule which is no doubt the correct one is given in a note below. This report seems to be responsible for Weed's statement that the Jefferson limestone locally grades into quartzite and sandstone. No cases of such grading have been observed by the present writer. The quartzite at Philipsburg, referred to by Weed, from which the fossils came has been examined by the writer, who agrees with Mr. Calkins that it represents a Carboniferous horizon apparently identical with the Quadrant.

From the foregoing it will be seen that the published data regarding the age of the Jefferson limestone are very scanty and by no means conclusive.

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[18]Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 288.

[19]Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 288.

NOTE. I avail myself of this opportunity to correct an error which I made eight years ago in identifying as Devonian a small lot of fossils from

Evidence of the fauna.—The fauna of the Jefferson limestone as known at present is a small one, numbering about 32 species. Like many other western faunas it includes very few species which are common to the standard sections east of the Mississippi. Of the five species which are common to the well-known eastern sections all except *Atrypa reticularis* are characteristic Devonian species, a sufficient number to make evident the Devonian age of the fauna.

In looking for the equivalent of this fauna among western Devonian faunas, the geographic proximity of the Ouray fauna invites comparison of the two. Such comparison, however, shows that the resemblance is slight and the differences are most pronounced. *Camarotœchia endlichi* may be considered the most characteristic species of the Ouray fauna, for it has been found at practically every outcrop where that fauna has been recognized from northern Colorado to southern New Mexico. This species, although so abundant in the Ouray fauna, is entirely unknown in the Jefferson limestone. On the other hand, species which from their abundance in the Jefferson limestone may be regarded as dominant species are absent from the Ouray fauna. Three of the most abundant forms in the Jefferson limestone fauna are *Spirifer utahensis*, *Sp. engelmanni*, and *Martinia maia*. Neither of these three is known in the Ouray fauna. All three of these species, however, are characteristic fossils of the Nevada

near Philipsburg, Mont., in consequence of which the beds from which they came were included by Mr. Weed in the Jefferson limestone. (U. S. Geol. Survey, Ann. Rept. twentieth, pt. 3, 1900, p. 288). The fossils examined comprised five species, two Rhynchonellas which were compared with *Camarotœchia sappho* and *C. congregata*, and an external mold of a pelecypod identified as *Glyptodesma rectum*? an indeterminable Aviculipecten and a cyathophylloid coral. The two Rhynchonellas which had the internal structure and configuration of *Camarotœchia* rather than of *Pugnax*, were unlike any Pennsylvanian species known to me and afforded some warrant for the age determination then given out. A reexamination of this material, however, in connection with additional paleontologic and stratigraphic data, leaves no doubt that the age is really Carboniferous, probably Upper Carboniferous. The impression referred to *Glyptodesma rectum?* almost certainly belongs to a rare species of *Myalina* related to or perhaps identical with *M. deltoida* Gabb.—George H. Girty.

limestone in Nevada. Seven other species, or about one-third of the known fauna of the Jefferson limestone, occur also in the fauna of the Nevada limestone. So large a percentage of species common to the faunas of these two limestones leads to the conclusion that the two faunas are identical and that the Jefferson limestone of Montana and Utah is the stratigraphic equivalent of the Nevada limestone of Nevada. The only possible grounds for a different conclusion would be the presence of a fauna above or below the Nevada limestone having an equal or greater resemblance to the Jefferson limestone fauna. Walcott's[20] work on the Nevada faunas clearly indicates that there is no such fauna. The White Pine shale which follows the Nevada limestone is now known to be of Carboniferous age and contains, as indicated by Walcott[21], but one species which is common to the Nevada limestone—*Productus subaculeatus*. The Nevada limestone fauna is preceded in the section by a fauna of Silurian or Ordovician age[22].

The fauna of the Threeforks shale, which immediately follows the Jefferson limestone in some of the sections in Montana, is composed for the most part of alien species. Dr. Raymond's[23] list of the Threeforks shale fauna at Logan and Threeforks, Montana, shows but three species which are known in the Jefferson limestone. Evidently very few of the indigenous species of the Jefferson limestone survived the conditions which inaugurated the deposition of the shales that terminated the Devonian in this region.

Dr. Girty[24] has described a small Devonian fauna from the Threeforks limestone of the Yellowstone Park. As pointed out in a foot note p.4, Threeforks limestone and Threeforks shale have

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[20]Paleontology of the Eureka district. Mon. U. S. Geol. Survey, vol. 8, 1884, pp. 283, 284.

[21]Ibid, p. 5.

[22]Ibid, p. 4.

[23]On the occurrence in the Rocky Mountains of an Upper Devonian fauna with *Clymenia*. Am. Jour. Sci., vol. 23, 1907, pp. 120, 121.

[24]Devonian and Carboniferous fossils from the Yellowstone National Park. Mon. U. S. Geol. Survey, vol. 32, pt. 2, 1899, pp. 479–507.

been used for the same stratigraphic horizon, the former name having been used where limestone predominates over the shale. It might be expected that where this horizon is represented by limestone its fauna would resemble that of the Jefferson limestone more decidedly than where a shale followed the Jefferson. This presumption seems to be borne out by the small fauna described from it by Girty. This shows that the total number of species common to the Threeforks limestone fauna and the Jefferson limestone fauna, as recorded in this paper, is only three or the same number as the species common to the Jefferson limestone, and the Threeforks shale at Threeforks. But the proportion of the species common to the Jefferson limestone and the higher horizon in the two cases is quite different, being 37 per cent of the fauna described by Girty and only 4 per cent of that listed by Raymond. The resemblance of the fauna of the Jefferson limestone to that of the limestone facies of the Threeforks formation is thus seen to be much more pronounced than its likeness to the fauna of the Threeforks shale.

In attempting to determine just what part of the Devonian is represented by the fauna of the Jefferson limestone we find that two of the five species which are common to the Jefferson limestone fauna and the eastern Devonian fauna are Atrypas. One of these, *A. reticularis*, has no diagnostic value, while *A. spinosa* has a recorded range from the Corniferous to the Chemung. The other three species, *Schuchertella chemungensis arctostriatus*, *Productella spinulicosta*, and *Martinia maia*, are known in the eastern sections only in Middle Devonian horizons. The absence from the fauna of any of the large Productellas, which generally characterize the late Devonian faunas, together with the presence of an Upper Devonian fauna[25] following it in the section, both supplement the intrinsic evidence of the fauna that it is earlier than Upper Devonian. The known range of the fossils which are common to eastern sections suggest a Middle Devonian age for at least a part of the Jefferson limestone. The fauna contains no coarsely plicated Spirifers or other fossils generally characteristic of the early Devonian, but other evidence strongly

[25]Am. Jour. Sci., vol. 23, 1907, pp. 116–122.

supports the view that the Jefferson limestone represents both Lower and Middle Devonian. No evidence of a stratigraphic break between the Jefferson and the preceding formation has been observed by the writer in any of the sections examined by him. None of the folios[26] which describe the Jefferson limestone record any unconformity at its base. Peale[27] found no proof of a Silurian fauna in the Threeforks region, but considered sedimentation continuous from the Cambrian to the Devonian. He expressed the belief that "we need not be surprised if some time in the future this now barren interval should somewhere furnish a mingling of Devonian and Silurian forms[28]." In Utah the writer has found conditions that seem to indicate there the continuity of sedimentation from the Silurian to the Devonian, which although probable in Montana has not been demonstrated. In the sections east of Cache Valley a Silurian fauna occurs in a white magnesian limestone[29] 200 feet to 300 feet thick. The much darker colored magnesian limestones (Jefferson limestone) which lie above the Silurian limestone contain an abundance of Devonian fossils in certain beds in the lower part of the formation. *Martinia maia* is the most abundant of these. Besides the Devonian fauna, *Halysites catenulatus* occurs rather commonly in the lower portion of the Jefferson limestone and is present also in the Silurian fauna below. Its occurrence in the Jefferson is the result, it seems most probable, of continuous marine conditions from Silurian to Devonian time, which permitted *Halysites* to continue into the post-Silurian period as an associate of the Devonian fauna. *Halysites catenulatus* was considered a diagnostic Silurian fossil until it was found associated with Ordovician faunas some years ago. The section under consideration shows that in Utah it ranges upward into the Devonian, and is apparently the first in which a post-Silurian horizon has been recorded for this species.

[26]Geologic Atlas U. S., folios, 1, 1894; 24, 1896; 30, 1896; 52, 1899, U. S. Geol. Survey.

[27]Geologic Atlas U. S., folio, 24, 1896, U. S. Geol. Survey, 1896, p. 2.

[28]Ibid, p. 2.

[29]Kindle, E. M., "Occurrence of the Silurian fauna in Western America." Am. Jour. Sci., vol. 25, 1908, p. 127.

The presence of this coral in the Jefferson limestone supplements in an important way the evidence afforded by the Devonian fossils as to the age of the lower portion of the Jefferson. As previously stated, the Devonian fauna contains none of the fossils commonly considered diagnostic of the Lower Devonian, but the occurrence in the lower part of the Jefferson of *Halysites catenulatus* affords stronger evidence of a horizon earlier than Middle Devonian than would even the most characteristic early Devonian species. If the validity of this evidence be conceded, then we must conclude that both the Lower and Middle Devonian are represented by the Jefferson limestone.

DESCRIPTION OF THE FAUNA[30].

CŒLENTERATA

Stromatopora sp.

One or more species of this genus are rather common in the Jefferson limestone. The character of the rock inclosing them is not such as to preserve the minute structures sufficiently well to determine the species.

Locality:—Sixteen P. O. and Princeton, Montana.

Favosites cf. *limitaris* Rominger.

Pl. I fig. 2.

A form apparently closely related to this species is one of the most generally distributed fossils in the Jefferson limestone. It occurs generally, however, in a very poor state of preservation, making specific identification uncertain.

Locality:—Princeton, Philipsburg, Logan, Sixteen P. O., Montana; Paradise P. O., Utah.

Spirorbis sp.

Pl. I fig. 1.

Specimens of this minute shell occur on the surface of a

[30]The types of the new species described in this paper belong to the collections of the U. S. Geological Survey.

pelecypod. The specimens are poorly preserved and the specific characters are not well shown. An average-sized specimen has a diameter of 1½ mm.

Locality:—Logan, Utah.

BRACHIOPODA [31].

Productella cf. *spinulicosta* Hall.

Pl. I figs. 3–3a.

Shell small, concavo-convex. Surface marked by obscure concentric wrinkles and fine concentric striæ. A few spine bases are distributed irregularly over the surface. These are of circular form and are not connected with the short ridgelike elevations which characterize *P. spinulicosta.* In the absence of short ridgelike tubercles this form resembles *P. pyxidatus.* This shell is evidently identical with the one which Meek identified as *P. subaculeatus* (?) from the dark limestone of the White Pine district, Nevada. There is no indication of rows of spine bases or tubercles which characterize the species in New York.

It is not improbable that larger collections will require the separation of these forms as a new species, which seems hardly desirable with the present material.

Locality:—Paradise P. O., Utah; Princeton, Montana.

Stropheodonta cf. *macrostriata* (Walcott)

A few imperfect specimens from the East Fork of Rock Creek are doubtfully referred to this form.

Locality:—East Fork Rock Creek, Princeton Quadrangle, Mont.

Stropheodonta sp.

A single pedicle valve of an undetermined species occurs in the collection. It is distinctly convex and marked by rather angular

[31]The types of the new species described in this paper belong to the collections of the U. S. Geological Survey.

[32]The reader is referred to Bull. 87 U.S. Geol. Surv. for the synonymy of the species described. The synonymy of the few species described in other groups may be found in Miller's North American Geology and Paleontology.

striæ crossed by fine concentric striæ of variable size.

Locality:—Princeton, Mont.

Schuchertella chemungensis var. *arctostriata* (Hall)

Pl. II figs. 1–1c.

The fossils referred to this species are marked by slender threadlike striæ of fairly uniform size and crossed by fine concentric striæ.

The specimens from Princeton are much smaller than those from Livingston, which average about three-fourths of an inch in width. The largest of the three specimens from Livingston measures about one-half inch in width.

Locality.—Phillipsburg and Livingston, Montana; Logan, Utah.

Schuchertella extensus, n. sp.

Pl. I figs. 8–8b.

Shell elongate, and plano-convex.

Pedicle valve moderately convex, sloping rather regularly to the front and sides. Beak somewhat twisted. Area very high and strongly inclined backward; its height equals nearly two-thirds the length of the hinge line.

Brachial valve nearly flat with a slight concavity on one side the median line.

Surface marked by rather strong rounded striæ of uniform size. From five to six striæ occupy the space of 2 mm. at the anterior margin of shell.

This species is distinguished from others of the genus by the high area and short hinge line and elongate form.

Locality.—Sixteen P. O., Montana.

Camarotœchia sp.

The collection contains two fragmentary specimens of a *Camarotœchia* of undetermined species.

Locality.—Paradise P. O., Utah.

Leiorhynchus utahensis n. sp.
Pl. III figs. 1–1c.

Shell large, subglobose, the valves unequally convex.

The pedicle valve is characterized by a broad sinus which is obsolete near the umbone but deepens and widens rapidly toward the front, occupying half the width of the shell in the latter region. In the anterior third of the shell the sinus bends abruptly, forming a tonguelike extension into the end of the fold of the opposite valve.

A nearly flat area lies on either side the sinus in the posterior part of the valve which is abruptly geniculated near the margin of the shell, forming a broad band flanking the margin of the shell from the beak to the tonguelike extension of the sinus. Three to five coarse, rounded plications occupy the sinus. Surface smooth on either side. Beak small and rather closely incurved.

Dorsal valve convex, with a broad fold at the front becoming obsolete near the beak. Three or more plications occupy the fold (three in the only specimen observed which belongs to a young shell). Shell smooth on either side of the fold and curving uniformly to the margin.

The largest specimen in the collection has a length and breadth of 30 mm. This species is closely related to an undescribed form occurring in the Threeforks shale at Logan and Melrose, Montana, but differs from that species in the more triangular outline of the posterior part of the shell and in being narrower. The postcardinal slopes of the Montana shells also seem to be more strongly inclined. The differences between the two forms, however, are probably not much more than varietal.

Locality.—Paradise, P. O., Utah.

Hypothyris (?) *globularis* n. sp.
Pl. I. figs. 9–9b.

Shell small and globulose, the globular form interrupted only by the slightly projecting beak of the pedicle valve. Valves of equal size.

Pedicle valve uniformly and strongly convex, without sinus. Beak projects slightly beyond the opposite valve. Line of junction of the two valves bends upward gently against the dorsal valve at the front, suggesting a sinus.

Brachial valve hemispheric without fold.

Surface marked by fine concentric striæ and stronger distinct lines of growth. Very weak plications are present at the anterior margins of the valves, but these are unrecognizable in the middle and posterior portions of the shell.

Shell impunctate.

The species is represented by a single specimen which measures 5½ mm. in length and 5mm. in breadth.

The absence of a fold and sinus distinguishes it from the other species of the genus to which it is provisionally referred.

Locality.—Princeton, Montana.

Atrypa reticularis (Linn)

Pl. I. fig. 6.

Typical examples of this species occur in this fauna. It is not, however, a common species and it has not been observed in association with any of the other species of the genus.

Locality.—Sixteen P. O. and Flat Iron Mountain, Lewis and Clark Forest Reserve, Montana; Manson station, Idaho.

Atrypa spinosa var. *montanensis* n. var.

Pl. I figs. 5--5c.

Shell small, suborbicular, valves equally and moderately convex.

Ventral valve with pointed beak extending beyond the opposite valve but not incurved.

Dorsal valve with small, closely incurved beak.

Surface of each valve marked by 14 to 20 strong rounded costæ bifurcating at irregular intervals and increasing in strength from the umbonal region to the margin. These are crossed by lamellæ which form concentric bands of nodes on the costæ. Both valves are regularly convex except in the portions near the outer extremities of the hinge line, which are somewhat flattened.

The species is represented by a number of shells. The largest of these has a width of 10¼ mm. and a length of 9¾ mm. The small size, depressed shell, and extended beak in the pedicle valve serve to distinguish it from *Atrypa spinosa* of the ordinary type. *A. missouriensis*, which is associated with it, is readily distinguished by its more numerous and much finer striæ.

Locality.—Livingston, Montana.

Atrypa hystrix var. *occidentalis* (Hall)

Pl. I fig. 4.

This species is represented by several specimens of imperfect shells characterized by 10 to 20 very coarse nodose plications on each valve.

Locality.—Princeton, Montana.

Atrypa missouriensis Miller.

Pl. I figs. 7–7b.

Shell small subcircular, the valves nearly equally convex.

Greatest convexity of the pedicle valve in the umbonal region, from which it slopes regularly to the sides. Beak of the pedicle valve pointed, but slightly incurved and extending beyond the hinge line. Area small.

Pedicle valve in general uniformly convex, but in some specimens with a slight undefined depression along the median line from the umbone to the front. Beak small and incurved. Surface covered by 40 to 80 fine bifurcating striæ. Fold and sinus absent. Average specimens have a length and breadth of about 9 mm. and a thickness of 3½ mm.

Locality.—This is a rather abundant shell at Princeton, Montana.

Athyris parvula Whiteaves.

Pl. III figs. 2–2c.

Four specimens represent this species. The largest has a length and breadth of 9 mm. and has the fold and sinus rather more prominently developed than indicated in Whiteaves'[33]

[33]Contribution to Canadian Paleontology, vol. I, pt. 3, 1891, pl. 32, Figs. 4 and 5.

figures. The smallest specimen measures 4 mm. in width and 4¾ mm. in length. This shell shows no trace of the fold and sinus characterizing the mature shells. A slightly larger specimen shows the fold and sinus barely perceptible beyond the anterior margin of the shell, where they are distinctly marked.

Locality.—Princeton, Montana.

Athyris montanensis n. sp.

Pl. III figs. 3–3b.

Shell small, subcircular in outline. Dorsal and ventral valves moderately and about equally convex. A broad fold and sinus are developed near the front of the shell, but are obsolete a short distance posterior to the front. The sinus is a slightly convex broad low and depressed ridge in the anterior half of the value. Two or three low, broadly rounded but rather indistinct plications are discernible on either side the fold and sinus at the margin of the shell, but obsolete a very slight distance from the front.

The broad sinus, slightly concave in the middle, distinguishes the species from *Athyris vitata* and its varieties, with which it seems closely allied in other respects.

The species is represented by two specimens of almost precisely the same size, having a length and breadth of 7 mm. and maximum thickness of 5¼ mm.

Locality.—Princeton, Montana.

Spirifer occidentalis n. sp.

Pl. III figs. 4–4d.

Shell small, plano-convex, subcircular in outline. Hinge line rounded at the extremities.

Ventral valve convex, very gibbous and elevated in the umbonal region. Beak obtuse and closely incurved over the small delthyrium. Area small and inconspicuous. A broad, shallow sinus in anterior third of shell terminates in a tonguelike extension corresponding to fold in dorsal valve. Sinus flanked by low rounded ridges at the front. Both ridges and sinus are obsolete in posterior two-thirds of valve. Indications of a second plication on either side the sinus are seen at the front of the

shell in some specimens. A pair of dental lamellæ extend across the umbonal cavity.

Dorsal valve comparatively flat but rounding off toward the lateral extremities and the hinge line. A broad, median fold which is depressed to or slightly below the level of the sides of the valve is present. It is limited by a shallow groove on either side and tapers to a point at the umbone. Etched specimens show laterally directed spiralia consisting of three or four coils.

This species shows but little likeness to any other species of the genus *Spirifer* in which it is placed provisionally. Externally it has some resemblance to the species of *Metaplasia* in the inequality of the valves and small number of plications. The presence of dental plates, however, bars it from this genus.

Spirifer utahensis Meek.

Pl. II figs. 2–2c.

Comparison with Meek's types shows unquestionable identity of the Montana forms with the Nevada species, although such identity is not altogether evident from Meek's description. In Meek's specimens the striæ on the fold and sinus are less than eight (his minimum number) in all but the largest specimen. Only two of the types show clearly the character of the fold, and in these it differs materially in development. In the Montana collection, which numbers 40 or 50 specimens, the fold is rather variable. In some specimens it is elevated above the adjacent portion of the shell barely enough to be recognizable except at the anterior margin. Generally, however, it is moderately prominent from the beak to the front. The sinus, though generally more prominent than the fold, is in a few specimens extremely shallow. The striæ on the fold and sinus range in number from four to nine. The striæ marking the surface of each valve do not in general exceed 35 in number.

This is one of the most abundant species in the Montana fauna.

Locality.—Princeton, Montana.

Spirifer englemanni Meek.
Pl. II figs. 3–3b.

Shell subhemispheric in outline. Valves unequal, the dorsal valve moderately convex, the central valve greatly elevated in the umbonal region. Surface of shell marked by 14 to 20 radiating rounded plications. The entire surface is covered by very fine radiating striæ. These finer markings are generally absent through exfoliation, but three or four of the Montana specimens show them distinctly. They are also well preserved in specimens from the Eureka district, Nevada, identified by C. D. Walcott.

Ventral valve with a very high area inclined slightly backward near the beak, which is small and pointed and slightly incurved. A rather broad and shallow sinus extends from the beak to the front. Dorsal valve with rather low fold.

The only notable differences observed between the specimens described and the types are the height and backward curvature of the area of the ventral valve. In the types the latter feature exceeds the curvature seen in the Montana specimens, but the height is less. These differences, however, are not believed to be of specific value.

Locality.—Princeton, Montana.

Spirifer cf. *argentarius* Meek.
Pl. II figs. 4–4a.

Some small shells with nonplicated fold and sinus are referred to this species. One specimen shows traces of somewhat lamellose concentric striæ, which, together with the greater prominence and coarseness of the lateral striæ and less elevated area, distinguish it from *Sp. engelmanni.*

Locality.—Princeton, Montana.

Spirifer disjunctus var. *animasensis* Girty.

This form, which is distinguished from *Sp. disjunctus* by the high area and subpyramidal form and slightly twisted beak is present only in the Utah collections. *Sp. disjunctus*, which is so common in the Threeforks shale above the Jefferson limestone,

has not been observed by the writer in the latter formation. Peale[34] reports it in the uppermost part of the Jefferson limestone at Logan, but it is probable that the form listed by Peale is the variety since distinguished as *animasensis*.

Locality.—Paradise P. O., Utah, Manson Sta., Idaho.

Martinia maia (Bill)

Pl. IV figs. 1–1g.

The rather large collection of specimens from the Logan Canyon section show considerable variation with respect to outline of shell, gibbosity, and height of area. The narrow elongate type is represented by shells in which the length exceeds the width, whereas in some of the broad types the width is equal to $1\frac{1}{5}$ times the length. An incurved ventral beak, a gibbous umbonal region, a short hinge line, and rounded cardinal angles generally characterize the elongate type of shell. The broad shell shows a slightly incurved ventral beak, a less gibbous umbonal region, and a long hinge line. A slightly incurved ventral beak and high area characterize some shells of the long, narrow type.

These specimens exhibit about the same kind and amount of variation as shown by specimens from Nevada. None of the Utah specimens, however, attain the large size shown by a few of the Nevada specimens. Although the outer surface of the shell is smooth, exfoliated specimens show fine striæ which characterize the inner surface of the shell, as shown in the illustrations.

Locality.—Logan, Utah; Rock Creek, Montana.

PELECYPODA

Pterinopecten sp.

Pl. IV fig. 5.

Shell small, subrhomboidal, regularly rounded. Left valve moderately convex. Posterior ear rounded and rather flat. Anterior ear unknown. Surface marked with strong radiating

[34]Bull. U. S. Geol. Survey No. 110, 1893, p. 29.

plications, with one or two finer plications occupying the intervening spaces between the stronger ribs. Fine concentric striæ cross the plications.

This fossil is known from a single left valve.

Locality.—Paradise P. O., Utah.

Actinopteria (?) sp.

A fragment of the cast of a left valve shows a shell with strong equal radiating striæ crossed by fine concentric striæ. Posterior ear with deeply concave margin.

Locality.—Paradise P. O., Utah.

GASTROPODA

Platyceras sp.

A small fragmentary specimen of *Platyceras* marked with fine transverse striæ occurs in the collection from Princeton, Mont.

Naticopsis sp.

Two casts of a shell having a general resemblance to *N. levis* occur in the collection. The material is too poor to permit specific determination.

Locality.—Logan, Utah.

Loxonema approximatum Walcott?

The collection contains two poorly preserved specimens in which the surface characters are not preserved, but which have a general resemblance to this species and may be identical with it.

Locality.—Princeton, Montana.

Tropidocyclas sp.

Pl. IV fig. 6.

A single fragmentary specimen of a strongly compressed discoidal form is present in the collection. The surface is marked by strong riblike striæ, rather widely spaced, which make a sharp retral curve from the margin of the umbilicus to the periphery.

Locality.—Logan, Utah.

Pleurotomaria sp.

Pl. IV fig. 2.

The collection contains eight or ten specimens too imperfect for complete description. The spire consists of four or five whorls reaching an elevation two or two and a half times the diameter of the base of the shell. Two strong revolving lines mark the whorls; these are placed rather close together and appear to border the slit band, the uppermost following the median line of the whorl. An angular shoulder stands midway between the upper margin and the middle of the whorl. This is occupied by small, closely placed nodes.

Locality.—Logan, Utah.

Loxonema nobile Walcott.

Pl. IV fig. 3.

The collection contains a single specimen of a large, robust form apparently identical with this species. The surface markings are not preserved.

Locality.—Flat Iron Mountain, Lewis and Clark Forest Reserve, Montana.

OSTRACODA

Bythocypris? sp.

Pl. IV fig. 4.

A small, minutely granulose ostracoid occurs in the Utah collection. An average specimen shows a length of 1½ mm. and width of 1 mm., with rather gibbous valves. It probably belongs to the genus *Bythocypris* and suggests the Devonian variety of *B. phillipsiana* Jones and Hall. The Utah specimen differs mainly in the greater development of the ventral border in the overlapping valve.

Locality.—Paradise P. O., Utah.

EXPLANATION OF PLATES

PLATE I.

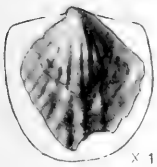

X 10

1


3 a X 2


X 1

2


X 1

4


X 1

3


5 c


5 X 1

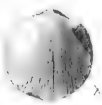

5 b

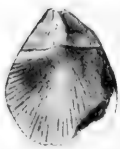

5 a

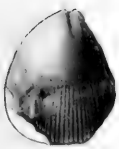

6 X 1


7 X2


7 a


7 b X 1


8 X1

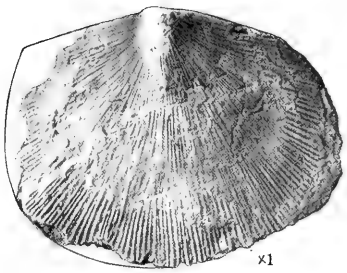

8 a


8 b


9 X2


9 a


9 b



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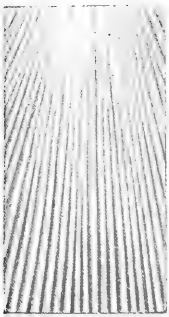
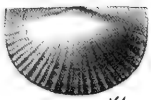
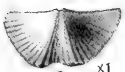


1a x4

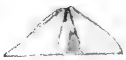
1b



1c x4



2 x1



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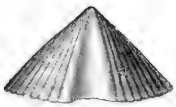
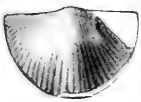


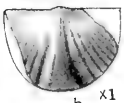
3 x2



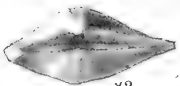
2b

2c x1

3a



3b x1



4 x2

4a

PLATE II.

Schuchertella chemungensis var. *arctostriatus* 26

Fig. 1. View of ventral valve, Livingston, Mont. (x 1)
1a. View showing detail of surface striæ (x 4).
1b. Side profile outline of specimen shown in fig. 1.
1c. A dorsal valve of small specimen, Princeton, Mont. (x 4)

Spirifer utahensis 31

Fig. 2. View of ventral valve. Princeton, Mont. (x 1)
2a. View of the area of the same specimen.
2b. A dorsal valve. Princeton, Mont. (x 1)
2c. Dorsal valve of specimen showing more prominent fold than fig. 2b. Princeton, Mont. (x 1)

Spirifer engelmanni 32

Fig. 3. View of a ventral valve. Princeton, Mont. (x 2)
3a. Side profile view of the same specimen.
3b. View of a dorsal valve of another specimen. Princeton, Mont., (x 1)

Spirifer cf. *argentarius* 32

Fig. 4. View of area and beaks of an exfoliated shell. Princeton, Mont., (x 2)
4a. A ventral view of the same specimen, the termination of the plications anterior to the umbonal region in this and the preceding figure is due to exfoliation of the shell.

PLATE III.

Leiorhynchus utahensis n. sp 27

Fig. 1. Ventral valve of the type specimen. Paradise P. O., Utah, (x 1)

1a. Front profile view of the same specimen. (x 1)

1b. View of a small dorsal valve. Paradise P. O., Utah. (x 1)

1c. View of a ventral valve. Paradise P. O., Utah. (x 1)

Athyris parvula 29

Fig. 2. A ventral view. Livingston, Mont. (x 2)

2a. View of the beaks of the same individual. (x 2)

2b. Dorsal view of specimen with ventral beak slightly broken. Livingston, Mont. (x 1)

2c. Front view of same specimen.

Athyris montanensis n. sp 30

Fig. 3. A dorsal view. Princeton, Mont. (x 2)

3a. A ventral view of the same specimen.

3b. A front view of the same individual.

Spirifer occidentalis n. sp 30

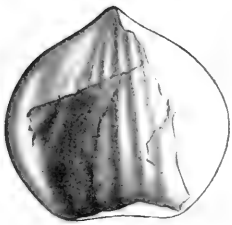
Fig. 4. A ventral view. Princeton, Mont. (x 2)

4a. Dorsal view of the same specimen.

4b. Front view of the same specimen.

4c. Side profile view of another individual. Princeton, Mont. (x 3)

4d. View of shell with ventral beak ground to show the septæ in umbonal cavity. Princeton, Mont. (x 3)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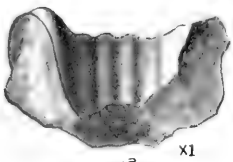
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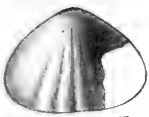
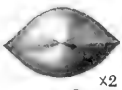
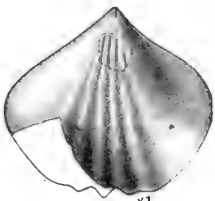

1b x1

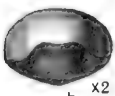

2 x2


2a x2


1c x1


3 x2


3d x2

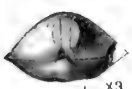

3b x2


4 x2


4a x2


4b x2


4c x3


4d x3


2b x1


2c


1 x1


1a

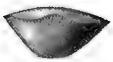

1b x1


1c

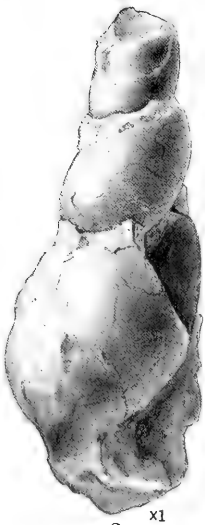

1d


1e


1f x1


1g


2 x2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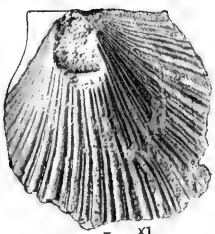
4 x2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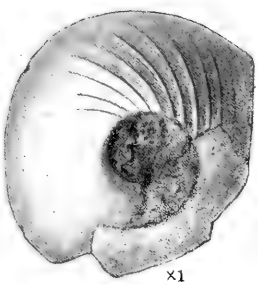
6 x1

PLATE IV.

Martinia maia[a] 33

Fig. 1. Dorsal view of small individual. Logan, Utah. (x 1)

1a. Front view of the same individual.

1b. Dorsal view of a larger specimen with a high and slightly incurved area in the ventral valve. Logan, Utah, (x 1)

1c. Front view of the same.

1d. Dorsal view of a completely exfoliated shell, showing the fine striæ which characterize the inner surface of the shell. Logan, Utah. (x 1)

1e. Side profile of the same.

1f. Dorsal view of a broad individual. Logan, Utah. (x 1)

1g. Front view of the same showing fine striæ similar to those in fig. 1d. Logan, Utah.

Pleurotomaria sp 35

Fig. 2. View of an exfoliated shell. Logan, Utah, (x 2)

Loxonema nobile 35

Fig. 3. View of a natural cast of shell. Flat Iron Mountain, Lewis and Clark Forest Reserve, Mont. (x 1)

Bythocypris? sp 35

Fig. 4. A view of a left valve showing part of overlapping border. Paradise, Utah, (x 2)

Pterinopecten sp 33

Fig. 5. View of left valve. Paradise P. O., Utah. (x 1)

Tropidocyclas sp 34

Fig. 6. View of a fragmentary specimen. The inner whorl is too broad at the point of overlapping. Logan, Utah. (x1)

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[a]In figures 1 and 1b the shell was tilted slightly upward at the beaks in order to show the area of the ventral valve.

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NEW OLIGOCENE SHELLS FROM FLORIDA

BY

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Introduction

Some years ago a collection of fossils from the Florida Oligocene was made by Professor G. D. Harris, assisted by Mr Arthur Veatch and others, for the Museum of Cornell University The material, of which there was a large quantity, was worked over at the time by the writer, and described species were identified, but a large number were new. These were set aside to await the completion of Dr. Dall's Monograph on the Florida Tertiaries, as it was thought that many of the new species would be therein described by Dr. Dall. Such proved to be the case Some forms in the Cornell collection however still remained undescribed, and these are now named and described in the following pages.

In addition to the new species from the Cornell University collection, Mr. T. H. Aldrich has most generously placed at the writer's disposal for description a number of new Florida species from his own large private collection in Washington.

Many thanks are due Dr. Dall for his kindness in opening his collections to the writer for comparison with the Cornell shells, and for many helpful suggestions in regard to determinations of species.

The drawings have been made with great accuracy and beauty by Miss Rena B. Johnson, of New York City.

DESCRIPTION OF SPECIES

Gastropoda

Actæon luculi, n. s.

Plate, I fig. 1

Shell small, immature, three-whorled, the nucleus smooth, the succeeding whorls sculptured with fine spiral striæ. Aperture oval, outer lip thin. When more specimens are obtained, this may prove to be the young of the following species.

Length of shell 2, greatest width 1 mm.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Actæon hamadryados, n. s.

Pl. I, fig. 2.

Shell small, with an acute spire and tumid body-whorl, five-whorled; suture distinct, deeply channelled; lower two-thirds of the body-whorl ornamented with incised spiral lines which tend to alternate in strength above and become much closer and more sharply cut towards the base; outer lip simple; aperture elliptical; pillar with a moderately strong plait. Length of shell 4, greatest width 2 mm.

Oak Grove, Florida.

Cornell University collection.

Terebra calhounensis, n. s.

Pl. I, fig. 3.

Shell of moderate but varying size; largest specimen twelve or thirteen-whorled; spiral sculpture of a single groove incising the upper portion of the whorls. This groove closely resembles the suture, and with it and the included area forms a spiral band, one to three millimeters wide. Transverse sculpture on the earlier whorls of sharp, subequal, close-set riblets (much less conspicuous but more irregularly nodular on the sub-sutural bands than on the remaining part of the whorls); on the later whorls the riblets are progressively weaker, and become nearly obsolete on the body-whorl. Length of largest specimen 65, greatest

width 15 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Conus Draperi, n. s.

Pl. I, fig. 4.

Shell large, surpassing in size all the other species of the genus yet found in the Chipola beds. General form conic, with eight whorls exclusive of the eroded nucleus; spire moderately elevated, not convex in profile; last whorl distinctly shouldered; surface of shell eroded in small circular spots which may be an indication that the original color pattern consisted of small dark spots on a light ground. Transverse sculpture lacking except for faint lines near the base of the shell; lines of growth inconspicuous. Length of shell 60; greatest width 38 mm.

Chipola marls, Bailey's Ferry, Calhoun County, Florida.

Cornell University collection.

Named in honor of Mrs. Henry Draper of New York City.

Conus nemorideditus, n. s.

Pl. I, fig. 5.

Shell large, smooth, thin in proportion to its size; whorls eight exclusive of the eroded nucleus: spire moderately elevated, not concave in profile, last whorl of the shell full and rounded near the shoulder and tapering rapidly to a rather slender base. Spiral sculpture consisting only of rather faint raised lines on the lower one-third of the shell; lines of growth inconspicuous. Length of shell 70; greatest width 42 mm.

This is the largest species of Conus found in either the Oak Grove or Chipola beds. Only one specimen was obtained.

Oak Grove, Florida.

Cornell University collection.

Conus trajectionis n. s.

Pl. I, fig. 6.

Shell of medium size, elongately pyriform, with an elevated and very acute spire not convex in profile: whorls eleven, of

which the first two nuclear are smooth, the five following show a coronation under the lens, while the remainder have only a spiral ornamentation. Spiral sculpture of three or four strong threads on each volution of the spire. The spirals are absent on the last whorl below the shoulder, but are strongly developed near the base of the shell. Lines of growth inconspicuous. Length of shell 50; greatest width 26 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Pleurotoma boadiceoides n. s.

Pl. I, figure 7.

This species is a miniature of *P. boadicea*, Dall, for with an equal number of whorls it is but half the size of the specimen figured by Dr. Dall. Whorls eight, of which the first two are smooth, the third strongly carinated and the remainder ornamented with riblets and spirals. Spiral sculpture of equal threads that can easily be seen without a lens; eighteen or twenty are present on the last whorl, and two or three on the preceding whorls. Longitudinal sculpture of nodular riblets (seven on the last whorl) occurring immediately below the subsutural grooves. Aperture narrowly elliptical; notch broad, not deep; outer lip simple, Length of shell 7; greatest width 2.5 mm.

It is possible that this may prove to be a small variety of *boadicea* when more specimens are found.

Oak Grove, Florida. Mr. Aldrich's collection.

Pleurotoma Kempi n. s.

Pl. I, fig. 8.

Shell small, short fusiform, whorls seven, of which the first three are smooth, the remainder sculptured; suture distinct, waved; spiral sculpture of fine, sub-equal threads visible without a lens, present on the body-whorl below the groove, absent (or worn) from the spire. Longitudinal sculpture of nodular riblets (eight on the last whorl) developed just beneath the grooved

bands. Aperture oval; canal nearly straight; notch shallow. Length of shell 7; greatest width 3 mm.

Named in honor of Professor Kemp of Columbia University.

Oak Grove, Florida.

Mr. Aldrich's collection.

Drillia calligona n. s.

Pl. II, fig. 1.

Shell elongated, resembling in form the recent *Drillia ostrearum*, Stearns. Spire acute, nuclear whorls two, subsequent whorls seven, of which the two earlier show well-marked transverse ribs, but little or no spiral sculpture; spirals on the later whorls stronger, consisting of primaries with alternating finer, secondary threads in pairs; transverse ribs stronger and more numerous on the later whorls (twenty-five on the last) and more sharply defined; the intersecting ribs and spirals form a beautiful cancellation ornamenting the whorls up to the margin of the groove, where the ribs end abruptly; in the groove lines of growth and fine, sub-equal spirals form the only sculpture; upper margin of the groove marked by a sharp carination sloping steeply to the suture; aperture narrow with a smooth callus.

Length of shell 19; of last whorl 11; of aperture 8; greatest width 6 mm.

This very beautiful species is characterised by the delicacy and elegance of its sculpture.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Drillia dryados, n. s.

Pl. II, fig. 2

Shell of moderate size, rather strong, resembling *D. Grabaui*, with eleven whorls, of which the two nuclear are smooth; spiral sculpture of close equally inter-spaced grooves which extend over the entire surface of the shell except the nucleus and the crests of the transverse ribs which interrupt the grooves; trans-

verse sculpture of numerous, rather sharply-defined ribs (sixteen on the next to the last whorl) which tend to become fainter and obsolete on the body-whorl; subsutural band slightly nodular, undulated; aperture narrow; canal short; outer lip not lirate within; pillar with a moderate callus. Length of shell 21.5; of aperture 4; greatest width 7 mm. One specimen only.

Oak Grove, Santa Rose County, Florida.

Cornell University collection.

Drillia Grabaui, n. s.

Pl. II, fig. 3.

Shell of moderate size, strong, with about seven whorls in addition to the nucleus which is eroded in both specimens in the collection. Spiral sculpture of close, equal grooves with slightly wider interspaces, the spirals continuing without interruption over the transverse ribs and covering the surface of the shell except the earlier whorls and the region just beneath the suture; subsutural band nodular; transverse sculpture of rather sharply defined ribs (seventeen on the last whorl which extend over the whorls from the nodular, sub-sutural band to the succeeding suture and over three-quarters of the body whorl; notch only slightly indented; aperture rather narrow; canal short, wide; outer lip thickened externally, not lirate within; pillar with a moderate callus. Length of shell 26; of aperture 11; greatest width 9 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Professor Grabau of Columbia University.

Drillia Louisæ, n. s.

Pl. II, fig. 4.

Shell small, slender, acute, with eight whorls of which the nuclear are smooth; spiral sculpture consisting only of about eight fine, impressed lines at the base of the shell; transverse sculpture of slightly flexuous riblets which become obsolete on

the last third of the body whorl, their termination being marked by a more pronounced varix-like riblet ; space between this terminal rib and the outer lip showiug strong, transverse lines of growth. Ribs on the body whorl seven. Notch U-shaped, distinct ; outer lip thickened near the edge ; pillar with a moderate callus. Length of shell 9.5 ; greatest width 3.75 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Drillia Meunieri, n. s.

Pl. II, fig. 5.

Shell resembling *D. Grabaui* but much larger and stronger. Whorls without the nucleus, which is eroded in the single specimen found, eight ; spiral sculpture of sub-equal, shallow, narrow grooves extending from the notch to the base of the whorls ; subsutural band very slightly nodular ; transverse sculpture of fairly distinct ribs (thirteen on the last whorl) which become weaker and tend to fade out on the last whorl. The ribs extend from the notch to the succeeding suture and to about the center of the body-whorl. Notch distinct, broadly U-shaped ; canal short, wide ; aperture rather narrow ; outer lip not lirate within ; pillar with a rather thick callus. Length of shell 41 ; of aperture 18 ; greatest width 21 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Professor Stanislaus-Meunier of the Jardin des Plantes, Paris.

Drillia nemoralis, n. s.

Pl. II, fig. 6

Shell small, rather solid, about eight-whorled, nuclear whorls eroded in the specimen found ; spiral sculpture of raised threads covering the whorls except on the sub-sutural grooves, which are smooth ; transverse sculpture of riblets (seven on the body-whorl), which are strongest at the periphery of the volutions and do not cross the subsutural grooves ; aperture oval-elliptical ; notch slight and inconspicuous ; pillar with a moderate callus.

Length of decollate shell 10; greatest width 4.5 mm.

Oak Grove, Santa Rosa County, Florida.

Cornell University collection.

This species resembles in size and sculpture *D. Stonemani* from Bailey's Ferry, but in the latter shell the transverse ribs are more numerous and the notch is very conspicuous, while in this species it is only slightly indented.

Drillia Stonemani, n. s.

Pl. II, fig. 7.

Shell small, short fusiform, whorls about seven, of which the nuclear are smooth; spiral sculpture of raised threads which are absent only from the sub-sutural bands; transverse sculpture of fine riblets (ten on the body-whorl) with narrower interspaces; outer lip thickened near the edge which is crenulate on the inside margin; notch very marked and prominent; nearly O-shaped; aperture narrow; pillar with a slight callus. Length of shell 10; greatest width 4 mm.

Chipola marls, Bailey's Ferry, Florida.

Named in honor of Dr. Bertha Stoneman of the University of South Africa.

Cornell University collection.

Drillia Vandenbroecki, n. s.

Pl. II, fig. 8.

Shell slender, acute, with ten whorls, of which the three nuclear are smooth and shining; spiral sculpture of fine, subequal threads with wider interspaces. The threads extend over the sub-sutural grooves and thus cover the entire surface of the shell except the three nuclear whorls; transverse sculpture of well-marked riblets which extend from the base of the sub-sutural groove to the succeeding suture and down over more than one-half the body-whorl; aperture rather narrow; outer lip somewhat thickened near the edge; notch deep, distinct, U-shaped; pillar with a moderate callus; canal very short, open. Length of shell 13; of aperture 5; greatest width 4.5 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Professor Van den Broeck, Director of the Geological Survey of Belgium.

Mangilia Claræ, n. s.

Pl. III, fig. 1.

Shell small, slender, acute, seven-whorled, the two nuclear smooth and full; spiral sculpture consisting only of a few fine threads extending over the lower half of the body whorl; transverse sculpture of slightly oblique ribs (seven on the last whorl), most prominent at the periphery of the whorls. Length of shell 6.5; greatest width 2.5 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Mangilia Websteri, n. s.

Pl. III, fig. 2.

Shell very slender with seven whorls of which the two nuclear are smooth: body-whorl slightly less than half the length of the shell; transverse sculpture of nearly straight, elevated, prominent ribs, of which there are eight on the body-whorl (including the varix); spiral sculpture of close-set threads, tending to alternate in size, which cover the whole surface of the shell except the nuclear whorls.

Length of shell 8; of aperture 3; of body-whorl 4.5; greatest width 3 mm.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Dedicated to Dr. David Webster, of New York City.

Mangilia Isabellæ, n. s.

Pl. III, fig. 3.

Shell short, fusiform, whorls seven of which the two nuclear are smooth; body-whorl more than half the length of the shell; transverse sculpture of prominent, somewhat flexuous ribs (eight on the last whorl including the varix at the aperture); spiral sculpture of exceedingly fine raised threads, visible only with a

lens ; aperture narrow; interior smooth.

Length of shell 5 ; of aperture 2 ; of body whorl 3.5 ; greatest width 2 mm.

Oligocene of the Chapola marls, Bailey's Ferry, Florida.

Cornell University collection.

Mangilia nemorensis, n. s

Plate II, fig. 4.

Shell small, short fusiform, spire acute, whorls six, of which the first two are smooth, the remainder sculptured with fine riblets (eight on the last whorl) and fine spiral threads which are more prominent than in *M. Ramondi*. Length of shell 4 ; greatest width 1.5 mm.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Mangilia Ramondi, n. s.

Pl. III, fig. 5.

Shell small, slender, with an acute spire, whorls seven, of which the first two are smooth, the third ornamented with spiral threads, and the remaining whorls with both spirals and longitudinal riblets (eight on the last whorl). Spirals very close and fine, not visible without a lens. Aperture narrow, elliptical ; outer lip simple without internal liræ. Length of shell 5 ; greatest width 2 mm.

Named in honor of Monsieur Ramond of the Jardin des Plantes, Paris.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

This shell resembles in general form *M. Tarri* from which it differs in having no internal liræ and in the presence of spiral sculpture.

Mangilia Strabonis, n. s.

Pl. III, fig. 6.

Shell small, fusiform, with seven whorls, of which the first

three are smooth, the remainder ornamented with longitudinal riblets (seven on the last whorl) and very fine spiral striæ visible only with a lens. Last whorl more than half the length of the shell; aperture and canal narrow; outer lip simple with no internal liræ. Length of shell 4.5; greatest width 2 mm.

Dedicated to the Greek geographer Strabo who first appreciated the significance of fossil remains.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Mangilia Tarri, n. s.

Pl. III, fig. 7.

Shell small, slender, acute, six-whorled exclusive of the eroded nucleus; body whorl slightly more than half the length of the shell; suture distinct, somewhat wavy; sculpture consisting only of longitudinal flexuous riblets or waves of which there are six on the last whorl; aperture narrow; outer lip with internal liræ; callus moderate. Length of shell 6; greatest width 2 mm.

Named in honor of Professor Tarr of Cornell University.

Oak Grove, Santa Rose County, Florida.

Mr. Aldrich's collection.

Clathurella nemorensis, n. s.

Pl. III, fig. 8.

Shell small, slender, spire acute, whorls seven, of which the first two are smooth, the third with a single carination near the base, and the remaining four cancellated by the intersections of numerous fine spiral threads with slightly more widely separated fine longitudinal riblets. Aperture slightly less than one-third the total length of the shell. Sinus profound, U-shaped. Outer lip bearing an external varix and four plications within. Columella with three denticles. Length of shell 4.5; greatest width 2 mm.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Glyphostoma Aldrichi, n. s.
Pl. III, fig. 9.

Shell small, so closely resembling in size and sculpture *Pleurotoma boadiceoides* that, were it not for the characters of the mouth and for the strong terminal varix, it might be taken for that species. Whorls seven or eight of which all but the nuclear are sculptured. Spiral sculpture of equal threads (eighteen or twenty on the last whorl and three on the preceding whorls). Longitudinal sculpture of nodular riblets developed immediately below the sub-sutural grooves. Last whorl more than half the length of the shell; terminal varix strong, developed near the margin of the outer lip; aperture narrowly elliptical; notch U-shaped, profound; outer lip with internal liræ; columella denticulate. Length of shell 7; greatest width 3.5 mm.

Named in honor of Mr. Aldrich.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Glyphostoma Harrisi, n. s.
Pl. III, fig. 10.

Shell of moderate size, strong, ten-whorled; spiral sculpture of sub-equal threads with wider interspaces, which cover the whole surface of the shell except on the sub sutural grooves where the threads become so faint as to be seen only with the aid of a lens or are obsolete; transverse sculpture of well-marked ribs with slightly narrower interspaces. The ribs extend from the base of the sub-sutural groove to the succeeding suture and to about half-way down the body whorl. Notch very distinct, deeply cut, narrowly U-shaped; outer lip with a thick external varix near the edge; lirate within especially anteriorly; aperture rather narrow; canal short; pillar with about 14 denticulate liræ, callus slight. Length of shell 20; of aperture 10.5; greatest width 9 mm.

Chipola marls, Bailey's Ferry, Florida. Two specimens.

Cornell University collection.

Named in honor of Professor G. D. Harris by whom the

Cornell collections of Tertiary fossils have been made.

Olivella diadematophoros, n. s.

Pl. IV, fig. 1.

Shell small, rather tumid, four-whorled; suture deeply channelled; surface smooth except for a diadem-like coronation. Outer lip simple, thin, pillar with two strong folds. Length of shell 3; greatest width 1.5 mm.

Oak Grove, Florida.

Mr. Aldrich's collection.

Marginella chipolana, n. s.

Pl. IV, fig. 2.

Shell small, biconic, broad in proportion to its length, smooth and polished, four-whorled; spire acute; suture distinct; aperture rather broad, two-thirds the length of the shell; outer lip thickened, marginated externally, with about ten denticles extending along the inner margin from the anterior to the posterior canals, the posterior denticles being the most prominent and widely separated while the anterior are small and crowded; inner lip with four sub-equal plaits, the anterior being somewhat more oblique and pronounced.

Length of shell 6; greatest width 4 mm.

Oligocene of the Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Marginella Cornelliana, n. s.

Pl. IV, fig. 3.

Shell of moderate size, biconic, very smooth and highly polished, four-whorled, the convexities of the whorls of the spire not wholly concealed by the callus glaze; aperture fully two-thirds the length of the shell, rather narrow; outer lip thickened and reflexed, marginated sharply externally, bearing six nearly obsolete denticles, visible only with a lens; inner lip with a slight callus and four strong plaits, the anterior very oblique, the posterior nearly horizontal.

Length of shell 9 ; greatest width 4.75 mm.

Oligocene of the Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Marginella denticulatoides, n. s.

Pl. IV, fig. 4.

Shell long and slender, fusiform, apex acute ; suture not concealed by callus ; whorls four ; terminal varix narrow, sharply defined ; outer lip with four or five denticles within ; columella with four strong plaits. Length of shell 8 ; of aperture 4 ; greatest width 3.5 mm.

This speeies is of the same size and has the general aspect of *M. denticulata* Conrad but is much more slender, and thus resembles also *M. aureocincta* Stearns.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Persicula calhounensis, n. s

Pl. IV, fig. 5.

Shell rather small, stout, oval, highly polished ; spire so depressed as to appear quite flat, volutions hidden by a wash of callus ; body-whorl shouldered ; aperture extending the whole length of the shell ; outer lip thickened at the margin, finely serrate within ; inner lip with a callus terminated by a bordering ridge, and bearing five plaits of which the three posterior are horizontal and feeble, the anterior oblique and strong. Length of shell 5.5 ; greatest width 4 mm.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Persicula dryados, n. s.

Pl. IV, fig. 6.

Shell small, oval, spire depressed and involute, in adult shells covered with callus so as to conceal entirely the volutions ; aperture extending nearly the length of the shell ; outer lip very finely crenulate along the entire inner margin ; pillar washed over with callus, with four or five plaits of which the posterior

are very feeble, the anterior more oblique and stronger.

Length of shell 4.5 ; greatest width 3 mm.

Oligocene of the Oak Grove sands, Santa Rosa County, Florida.

Cornell University and Mr. Aldrich's collection.

Caricella Isabellæ, n. s.

Pl. IV, fig. 7.

Shell of moderate size, thick and strong, whorls six, exclusive of the eroded nucleus ; suture distinct. Sculpture consisting only of numerous longitudinal striations. Columella with four plaits ; canal short ; reflexed. Length of shell 27 ; of aperture and canal 18 ; greatest width 14 mm,

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Perplicaria prior, n. s.

Pl. IV, fig. 8.

Shell with five whorls ; nucleus consisting of a whorl and a half, smooth to the unaided eye but showing under the lens three revolving threads ; sculpture of the remaining whorls cancellate due to the intersections of the spirals (of which there are on the body whorl fifteen strong and an equal number of fine alternating threads) with obliquely transverse costæ ; suture distinct ; outer lip with a submarginal varix, lirate within along the entire length but more sharply so towards the base ; columella with three plaits, that nearest the base being nearly horizontal and denticulate, the second very oblique, and the uppermost slightly oblique ; pillar glazed with a slight callus.

Length of shell 14 ; greatest width 6 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

This interesting shell is the second species of the genus *Perplicaria* Dall yet described. The type of the genus, *P. perplexa* from the Caloosahatchie Pliocene was described by Dr. Dall in 1890. The Chipola shell resembles closely that species but differs from it in possessing much more oblique transverse costæ,

in having three instead of two columellar plaits, and in its proportionally broader form. But in other respects the earlier, Chipola, species shows the characters of its Pliocene descendant.

Mitra Barnardensis, n. s.
Pl. IV, fig. 9.

Shell with tip eroded, remeining whorls eight; suture distinct; transverse sculpture of sharply-defined riblets of which there are about twelve on the last whorl. These riblets extend from suture to suture and over three-quarters of the body-whorl. Spiral sculpture of grooves channelled in the interspaces between the riblets, and of about seven unequal threads on the canal; aperture narrow; columella with four plaits of which the two anterior are much less prominent; outer lip lirate within. Length of shell 13; greatest width 4.5 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Mitra scopuli, n. s.
Pl. IV, fig. 10.

A species closely related to *Mitra Barnardensis* occurs in the lower bed (Oligocene) of Alum Bluff, Florida. This species differs from the Chipola shell in its broader, shorter form and more convex whorls. Length of decollate shell 11.5; greatest width 5 mm.

Cornell University collection.

Mitra Myttonis, n. s.
Pl. V, fig. 1.

Shell small, slender, fusiform, whorls six; nuclear smooth; subsequent whorls sculptured with nearly straight transverse ribs and fine spiral grooves in the interspaces; penultimate whorl with fifteen ribs; body-whorl almost smooth over its latter third or half as the ribs become obsolete; outer lip lirate within; columella with three well-marked plaits.

Length of largest specimen 5; of last whorl 3; of aperture 1.5; greatest width 1.5 mm.

This little species bears some resemblance to Dr. Dall's *M. Holmesii* of the Caloosahatchie marls.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Mitra Berkeyi, n. s.

Pl. V, fig. 2.

Shell when perfect with about seven whorls, the single specimen found being decollated and showing only six. Transverse sculpture of riblets so extremely fine as to be barely visible without a lens on the three earlier whorls but becoming slightly broader on the last three whorls so as to be easily seen by the unaided eye. Spiral sculpture of revolving threads developed only on the last three whorls where they equal in strength the transverse riblets and form with them a most exquisite and delicate cancellation covering the entire surface of the three later whorls. Columella with four plaits; aperture elliptical; canal short, reflexed. Length of shell 9; greatest width 3.5 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Dr. Berkey of Columbia University.

Fusus Gilli, n. s.

Pl. V, fig. 3.

Shell with six convex whorls of which the first three are smooth and the remainder sculptured. Spiral sculpture of well-defined threads alternating in size. Longitudinal sculpture of rounded riblets (ten on the last whorl). Suture waved; pillar nearly straight; aperture and canal key-hole shaped. Length of shell 9; greatest width 4 mm.

Named in honor of Professor Gill of Cornell University.

Oak Grove, Florida.

Mr. Aldrich's collection.

Fasciolaria Kindlei, n. s.

Pl. V, fig. 4.

Shell small, slender, fusiform; earlier whorls eroded, remaining whorls, five; suture fairly distinct; transverse sculpture of

nine prominent, subequal ribs on each whorl ; spiral sculpture of prominent threads, with one or two alternating, much finer threads; outer lip thin, lirate within; canal long, nearly straight. Length of decollate shell 54; of aperture and canal 29 ; greatest width 16 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Dedicated to Dr. Kindle of the U. S. Geological Survey.

Siphonalia Kempi, n. s.

Pl. V, fig. 5.

Shell rather large, fusiform, with about eight shouldered whorls. Longitudinal sculpture of ribs ; strongly nodular at the periphery of the whorls, but all fade out immediately above and below the shoulders except the final rib which extends prominently almost to the base of the shell. Spiral sculpture of threads which tend to alternate with finer raised lines. Outer lip very strongly lirate within, the liræ usually resembling strings of very small beads. The spirals and internal liræ resemble those of *S. dilatata* Quoy. Length of incomplete shell 65 ; greatest width 33 mm.

Apparently no species of *Siphonalia* or *Chrysodomus* have yet been described from the Florida Tertiaries. This species is now placed in *Siphonalia* because of the strong internal liræ not present in *Chrysodomus*. Yet this has been done with hesitation because of the present distribution of *Siphonalia* in Pacific and Australian waters only. If the Florida shell is correctly placed in *Siphonalia*, it is an added indication of the affinities of the Gulf Tertiary fauna with that of the Pacific.

Chipola marls, Bailey's Ferry, Florida.

Dedicated to Professor Kemp.

Cornell University collection.

Phos Watsoni, n. s.

Pl. V, fig. 6.

Shell very small with five whorls of which the first three are smooth, the remainder sculptured. Spiral sculpture of fine

groovings visible only with a lens. Longitudinal sculpture of strongly marked riblets (ten on the body whorl) which are very oblique on the dorsal side of the shell. Aperture oval; canal short. Length of shell 3; greatest width 2 mm.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Dedicated to Professor Thomas Watson of the University of Virginia.

Nassa Berthæ, n. s.

Pl. V, fig. 7.

Shell tapering regularly to an acute apex; whorls eight in mature shells, the two nuclear being smooth, the subsequent whorls bearing each about twenty very regular, straight transverse ribs, extending the full length of the whorls; beneath the suture the ribs are cut by an incised spiral line so that their ends appear as a series of beads crowning the summit of each whorl; lower half of the body-whorl with about six spirals which become obsolete above the center of the whorl; aged shells have the outer lip lirate within and the callus of the columella plicate.

Height of shell 13; of aperture 5; greatest width 5.5 mm.

The striking features of this unusually beautiful *Nassa* are the regular and elegant riblets and the absence of spirals except just beneath the suture and on the base of the body-whorl.

Oligocene of the Chipola marls, Bailey's Ferry, Calhoun County, Florida and of the Oak Grove sands of Santa Rose County, Florida.

Named in honor of Dr. Bertha Stoneman of the University of South Africa.

Cornell University and Mr. Aldrich's collection.

Nassa Dalli, n. s

Pl. V, fig. 8.

Shell rather small with seven whorls, of which the first two are smooth, the remainder sculptured; spire acute: transverse sculpture of fine sub-equal threads (visible without a lens) with

wider interspaces. Longitudinal sculpture of strongly defined riblets (ten on the last whorl) and a terminal varix. Aperture elliptical; outer lip lirate within; canal short, recurved. Length of shell 7; greatest width 4 mm.

Named in honor of Dr. Dall of the Smithsonian.

Oak Grove, Florida.

Mr. Aldrich's collection.

Nassa Harrisi, n. s.

Pl. V, fig. 9.

Shell rather small, stout, with an acute spire; nuclear whorls two, smooth; subsequent whorls five; transverse sculpture of narrow, elevated ribs (ten to eleven on the last whorl) with wider interspaces; spiral sculpture of narrow, slightly raised bands (about eight on the last whorl), the band just beneath the suture forming nodular intersections with the ribs and thus giving the effect of a row of beads; outer lip with four or five lirations within; collumella plicate, the upper fold being the stronger.

Adult shells of this species resemble in form half-grown specimens of *N. Berthæ* but the beading beneath the suture is more prominent and the ribs much fewer than in that species, and the spirals are not obsolete on the center of the body-whorl.

Length of shell 8; of last whorl 5; of aperture 3; greatest width 4.5 mm.

Chipola Oligocene; Bailey's Ferry, Calhoun County, Florida, and also in the uppermost Oligocene of the Oak Grove sands, Santa Rosa County, Florida.

Dedicated to Professor G. D. Harris of Cornell University.

Cornell University collection.

Nassa Veatchi, n. s.

Pl. V, fig. 10.

Shell small, resembling in size the recent *N. acuta*, slender, nuclear whorls three, smooth; subsequent whorls also three, evenly rounded; transverse sculpture of nearly straight, narrow riblets, of which there are eight on the last whorl and a final,

prominent varix ; spiral sculpture (on the last whorl) of about ten raised threads, the upper six extending over nearly the whole whorl and forming nodular intersections with the ribs, the remaining four closely crowded at the base of the whorl, penultimate whorl with three spiral threads ; outer lip of aperture with six lirations inside ; columella with a slight callus.

Length of shell 4.5 ; of last whorl 2.5 ; of aperture 1; greatest width 2 mm.

Oligocene of the Chipola marls, Bailey's Ferry, Florida.

Named in honor of Mr. Arthur Veatch, now of the United States Geological Survey, who some years ago ably aided Professor Harris in making the collection of Florida Oligocene fossils for Cornell University.

Cornell University collection.

Astyris trajectionis, n. s.

Pl. VI, fig. 1.

Shell small, smooth and shining, seven-whorled ; spiral sculpture consisting only of about ten impressed lines at the base of the shell ; outer lip thickened near the margin so as to form a slight varix and with about half a dozen denticulate liræ within ; columella with a moderate callus. Length of shell 6 ; greatest width 2.5 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Astyris Dalli, n. s.

Pl. VI, fig. 2.

Shell very slender, smooth, acute, nine-whorled, the two nuclear whorls being very smooth and shining ; spiral sculpture consisting only of about ten to fifteen impressed lines at the base of the shell ; transverse sculpture limited to a varix like thickening near the edge of the outer lip ; margin of outer lip sinuous, with nine or ten denticulate liræ within ; columella with a slight callus. Length of shell 12 ; greatest width 4 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Dr. Dall of the Smithsonian.

Astyris Aldrichi, n. s.

Pl. VI, fig. 3.

Shell of moderate size, polished, with the general shape of *A. perfervida* Dall, but characterized by the presence of ten or more vertical riblets on the body-whorl just below the suture. Earlier whorls eroded, remaining whorls five, outer lip with about eight liræ within and a slight external varix near the margin, canal reflexed; columella with five weak denticles and a moderate callus on the anterior part. Length of decollate shell 14; greatest width 6 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Dedicated to Mr. T. H. Aldrich of Washington.

Astyris Aldrichi var. nemoralis, n. var.

Pl. VI, fig. 4.

Shell resembling the typical form from Bailey's Ferry but smaller, and with riblets on the next to the last as well as on the last whorl. Earlier whorls eroded, remaining whorls three; spiral sculpture of a varying number of impressed lines extending from the base of the shell to about midway or less up on the body-whorl; transverse sculpture of (on the last whorl ten to eleven) narrow, nearly straight, rounded riblets best developed at and near the sutures and becoming obsolete a short distance below them. These riblets are present only on the last whorl and a half and do not appear on the earlier whorls. Outer lip with a varix near the margin and with about eight sharply-cut liræ within; aperture narrow; canal reflexed; columella with about six denticles and a thin callus. Length of decollate shell 10; greatest width 5 mm.

Oak Grove, Florida.

Cornell University collection.

Murex Virginiæ, n. s.
Pl. VI, fig. 5.

Shell small with some resemblance to *Typhis*, trigonal, biconic; whorls six; the two later being sharply carinated at the shoulders. Varices six, the alternate three being much more pronounced and giving the shell its triangular form. Spiral sculpture of raised threads which on the last whorl alternate with one or two finer, intercalated lines. Fainter, longitudinal threads form with the spirals a fine cancellation on the last whorl. Aperture oval, slightly more than half the length of the shell; canal narrow, reflexed. Length of shell 15; greatest width 8 mm.

This shell recalls *M. shilohensis* Heilprin from the Miocene of Shiloh, New Jersey, but that species has eight sub-equal varices. The variety *Burnsi* of *shilohensis* has six varices like the Chipola shell but they are very much more prominent.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Murex Vaughani, n. s.
Pl. VI, fig. 6.

Shell small, pyriform, compact, resembling in shape young specimens of *M. messorius* Sowerby of the Pliocene and recent faunas. Whorls about six, the nuclear nearly smooth, the three later whorls bearing each seven varices. On the body whorl the varices are prominent, rounded, somewhat broader than the interspaces. The varices of the shell form nearly continuous, sinuous lines from near the apex to the base of the canal. Spiral sculpture of raised lines of which groups of two or three are much stronger and stand out prominently from among alternating feebler spirals. Outer lip with about ten strong internal liræ; aperture oval; canal not quite half the length of the shell. Length of the shell 22.5; greatest width 14 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Named in honor of Mr. T. W. Vaughan of the United States

Geological Survey.

Murex Veatchi, n. s.

Pl. VI, fig. 7.

Shell pyriform, small, with five somewhat convex whorls, transverse sculpture of numerous, prominent raised lines which show some tendency to alternate but in general are sub-equal, longitudinal sculpture of sub-equal varices (six on the last whorl) and of fine longitudinal raised lines which form with the spirals a very fine network, or honey-comb ornamentation. Aperture oval ; canal open ; outer lip lirate within. Length of shell 21 ; of aperture and canal 13 ; greatest width 12 mm.

Named in honor of Mr. Arthur Veatch of the United States Geological Survey who collected the shells.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Trivia chipolana, n. s

Pl. VI, fig. 8.

Shell globose, inflated, rather thin, ribs fine, numerous, about twenty-five on the lip where they form a line of fine but sharply-defined teeth. The ribs extend uninterruptedly over the dorsal area of the shell and occasionally divaricate towards the lateral margins. The shell shows a very faint medial dorsal ridge with barely visible grooves on either side. Length of shell 7.5 ; greatest width 5 ; height 5 mm.

It is interesting to note that this species from the Florida Oligocene is very like small specimens of *T. Europæa* Montagu from which it differs only in the faint dorsal groovings which are absent in the Europæan species. *T. Europæa* (*T. sphærlculata* Lam.) is found in the Miocene abroad being common in the Red Crag. Its present distribution is from the Mediterranean north along the continent to Norway. This species appears to be the nearest ally of the Chipola shell.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Erato chipolana, n. s.

Pl. VI, fig. 9.

Shell small, pear-shaped, highly polished; aperture very narrow; outer lip finely crenulate within; columella with a slight fold at the base in adult shells.

Length of shell 4; of aperture 3.5; greatest width 3 mm.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Rimella Aldrichi, n. s.

Pl. VII, fig. 1.

Shell slender, fusiform, immature, with nine whorls of which the first four are smooth, the fifth bears longitudinal riblets and the remaining whorls are ornamented with longitudinal riblets (sixteen on the last whorl) and closely set spiral threads. Some of the specimens bear one or two varices. Length of largest shell 12; greatest width 4 mm.

Oak Grove, Santa Rose County, Florida.

Mr. Aldrich's collection.

Bittium Judsoni, n. s.

Pl. VII, fig. 2.

Shell small, slender, acute, with seven to eight convex whorls, of which the first two are smooth and the remainder strongly sculptured. Spiral sculpture of raised threads (eight on the body-whorl and three or four on the preceding whorls); longitudinal sculpture of fine riblets (twelve on the body-whorl) and a single varix not far from the margin of the lip. Aperture oval; outer lip simple; thin, with no internal liræ. Length of shell 4; greatest width 1 mm.

Named in honor of Dr. Judson of Dobbs Ferry, New York.

Oak Grove, Florida.

Mr. Aldrich's collection.

Cerithiopsis, Ogilvies, n. s.

Pl. VII, fig. 3.

Shell small, slender, acute, with twelve whorls of which the

two nuclear are smooth ; varices about nine in all, only the two on the body-whorl being pronounced ; spiral sculpture on the upper whorls of three principal, beaded, primary threads separated by nearly equal inter-spaces in each of which lies a much finer, wavy, secondary thread ; spiral sculpture on the last whorl of five beaded threads (that nearest the suture being the most prominent) with alternating finer, sinuous threads, while on the base are about eight fine spirals ; transverse sculpture on the earlier six or seven whorls of numerous, narrow, riblets which become obsolete on the later whorls ; aperture oval ; outer lip usually with a varix ; canal short, recurved. Length of shell 11 ; greatest width 4 mm.

Bailey's Ferry, and Oak Grove, Florida.

Cornell University and Mr. Aldrich's collection.

Named in honor of Dr. Ida Ogilvie of Barnard College, Columbia University.

Isapis Myttonis, n. s.

Pl. VII, fig. 4.

Shell with five convex whorls ornamented with a beautiful cancellation formed by the crossing of the raised spiral bands and the longitudinal riblets. Number of spiral bands on the whorl preceding the last three, on the last whorl seven. These are crossed somewhat obliquely by less prominent longitudinal riblets and are slightly nodular at the intersections. Suture distinct ; spire acute ; aperture oval ; outer lip simple, crenulated within by the seven revolving elevated bands of the exterior ; columella arched, bearing within a single central tooth. Length of shell 8 ; of aperture 3 ; greatest width 4 mm.

This exquisite little shell is entirely distinct from *I. Dalli* Whitfield of the Miocene of New Jersey.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Litiopa palæosargassina, n. s.

Pl. VII, fig. 5.

Shell small, thin and delicate, polished, whorls four exclu-

sive of the eroded nucleus, rather convex. Sculpture consisting of very fine spiral striæ visible only under a lens. Aperture oval; outer lip simple, thin. Length of shell 5; greatest width 2.5 mm.

Oak Grove, Santa Rosa County, Florida.

Mr. Aldrich's collection.

Natica Judsoni, n. s.

Pl. VII, fig. 6.

Shell smooth and polished, small, with four sloping whorls; suture distinct; lines of growth conspicuous but not forming wrinkles; callus heavy especially on the body, but not extending over the profound sink. Length of shell 18; greatest width 13 mm.

Named in honor of Dr. Judson of Dobbs Ferry, New York.

Oak Grove, Santa Rose County, Florida.

Mr. Aldrich's collection.

Adeorbis Aldrichi, n. s.

Pl. VII, fig. 7.

Shell very small, flattened, four-whorled; suture very distinct; periphery slightly carinated; whorls smooth on the upper surface and with a single carination on the under surface around the profound umbilicus. Greatest diameter of shell 1 mm.

Oak Grove, Florida.

Mr. Aldrich's collection.

Scala Virginiæ, n. s.

Pl. VII, fig. 8.

Shell small, delicate, seven-whorled; nuclear smooth and polished, subsequent whorls convex, sharply separated by a deep suture; transverse sculpture of prominent, slightly oblique, sharp-edged, lamellar varices (ten on the body-whorl) which tend to coronate the whorls; spiral sculpture of microscopic striæ between the varices; aperture round.

Length of shell 3.75; greatest width 1.5 mm.

Only one specimen of this pretty species was found.
Chipola Oligocene, Bailey's Ferry, Florida.
Cornell University collection.

Eulima chipolana, n. s.
Pl. VII, fig. 9.

Shell elongated, very slender, highly polished and shining, smooth, whorls thirteen; the five nearest the apex inclining slightly from the main axis of the shell; aperture oval; outer lip simple, inner lip reflexed upon the columella.

Length of shell 9; greatest width 2 mm.
Chipola Oligocene, Bailey's Ferry, Florida.
Cornell University collection.

Eulima parasitos, n. s.
Pl. VII, fig. 10.

Shell very slender, small, smooth and polished, with seven whorls exclusive of the eroded nucleus; without sculpture.

Length of shell 4; greatest width 1 mm.
Oak Grove, Florida.
Mr. Aldrich's collection.

Eulima nemoralis, n. s.
Pl. VII, fig. 11.

Shell smooth and polished, small, immature, conic, *Niso*-like in general form; whorls seven; the earlier slightly convex; the remainder flattened; no sculpture except a basal carina on the last whorl.

Length of shell 3; greatest width 1.5 mm.
Oak Grove, Florida.
Mr. Aldrich's collection.

Eulima Scotti, n. s.
Pl. VII, fig. 12.

Shell very slender, acute, polished, about nine-whorled; sides of spire straight; suture visible only with a lens; outer lip thin; inner lip with a well-marked band-like callus.

Length of shell 8.5 ; of aperture 2 ; greatest width 2 mm.
Chipola marls, Bailey's Ferry, Florida.
Cornell University collection.

Niso Aldrichi, n. s.
Pl. VIII, fig. 1.

Shell small, smooth, polished and shining, conic, with a rapidly tapering and acute spire ; whorls nine, the first three slightly convex ; the following flattened. Shell without sculpture. Suture distinct ; basal keel of the last whorl sharply defined.

Length of shell 4 ; greatest width 2 mm.
Oak Grove, Santa Rosa County, Florida.
Mr. Aldrich's collection.

Syrnola trisintralirata, n. s.
Pl. VIII, fig. 2.

This species recalls *S. attenuata* Dall of the Pliocene and recent faunas but is larger with an additional whorl and with the last whorl proportionally much shorter than in that species.

Shell very slender, smooth, with seven flattened whorls exclusive of the heterostrophic and fragmental nucleus, suture very distinct ; aperture oval, with three liræ far within the shell ; plait on the pillar strong and conspicuous.

Length of shell 4 ; greatest diameter 1 mm.
Oak Grove, Florida.
Mr. Aldrich's collection.

Astralium Dalli, n. s.
Pl. VIII, fig. 3.

Shell small, depressed, trochiform, four-whorled, with eight slender spines at the periphery ; surface of the whorls coarsely wrinkled just beneath the spines and finely wrinkled just above the spines. Between these wrinkled bands are four faint spirals generally seen only with a lens. Base rather flat with four or five raised threads, either smooth or slightly beaded.

Height of shell 3.5 ; greatest width 5 mm.

Specimens of this species were described in 1892, but not named by Dr. Dall to whom the shell is now dedicated.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Calliostoma Palmeri, n. s.

Pl. VIII, fig. 4.

Shell with six whorls, the two nuclear smooth, inflated, the four subsequent whorls delicately ornamented with very finely beaded spirals which are sometimes separated by smooth spiral threads or by alternating smaller beaded spirals. Basal sculpture of nine prominent raised threads separated by much finer alternating lines.

This very pretty shell is undoubtedly the ancestor of *Calliostoma limulum* Dall from the Pliocene of the Caloosahatchie and Shell creek, Florida. The resemblance is so great that if *limulum* had not been described from a later period it would have seemed best to have placed the Chipola shell as a variety of that species. The main difference between the shells lies in the fact that while in the Chipola shell each fourth row of beading is much more prominent than the rest, in the Pliocene shell all the primary rows of beadings are sub-equal.

Height of shell 7 mm ; greatest width 7 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Lucapinella Cornelliana, n. s.

Pl. VIII, fig. 5.

Shell elliptical, compressed, foramen elliptical ; sculpture of sixteen, strong, radial ribs with sets of two or four intercalary radiating threads ; these and the ribs are crossed by about thirteen more prominent concentric threads which are crenulate at their intersections with the ribs ; interior of shell smooth ; foramen with a distinct elliptical, internal callus.

Length of shell 11 ; width 7.5 ; height 2 mm.

Chipola marls, Bailey's Ferry, Florida.
Cornell University collection.

Scaphopoda

Dentalium santarosanum, n. s.
Pl. VIII, fig. 6.

Shell rather thin, small, so slightly curved as to appear at first sight straight; smooth; more or less shining; without sculpture; lines of growth very faintly visible, cross section of shell circular.

Length of largest specimen 7; greatest diameter 1.5 mm.
Oak Grove, Santa Rosa County, Florida.
Mr. Aldrich's collection.

Cadulus Clarœ, n. s.
Pl. VIII, fig. 7.

Shell slender, small, curved; cingulum more or less differentiated, varying with individuals; cross section of shell elliptical.

Length of shell 5; greatest diameter 1 mm.
Oak Grove, Florida.
Mr. Aldrich's collection.

Pelecypoda

Perna solereperta, n. s.
Pl. VIII, fig. 8.

Shell very inequilateral, small, compressed, with the general outline of *P. ephippium* Linn. Unfortunately, the only valve found is broken, but the portion of the cardinal area that remains shows distinctly two of the series of cartilage pits. Exterior of the shell with numerous fine radiating riblets not appearing over the earlier 5 mm of the shell.

Length of shell 12; width 8 mm.

This appears to be the first true *Perna* found in the Florida Tertiaries.

Oak Grove, Santa Rosa County, Florida.
Cornell University collection.

Venericardia chipolana, n. s.

Pl. VIII, fig. 9.

Shell thick, small, rounded, inflated, with about seventeen narrow, elevated, radial ribs, which have an accompanying thread at the base on each side of the interspaces; the interspaces are somewhat narrower than the ribs; sculpture on ribs nodular or slightly imbricated; lunule extremely small, sharply impressed; beaks pointed, full, nine-elevenths of the total length from the posterior end of the shell; interior margin fluted.

Length of shell 11; height 10; diameter of one valve 4.5 mm.

Chipola Oligocene, Bailey's Ferry, Florida.

Cornell University collection.

Corbula Antoniæ, n. s.

Pl. IX, fig. 1.

Shell very thick and solid, inflated, nearly equilateral, rounded in front, compressed and pointed behind so as to look as if pinched, and having a well-defined carina extending from the back to the posterior margin; beaks low; sculpture of rather unequal and not very regular concentric ribs which are absent from the region near the beaks.

Length of shell 10; height 8; diameter of inflated valve 6 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Codakia magnolioides, n. s.

Pl. IX, fig. 2.

Shell small, fragile, very inequilateral, moderately inflated; general outline elliptical; beaks low but prominent; sculpture of very fine, even, radial ribs, extending from the beak to the margin, and crossed by equal, fine, rounded concentric threads. A delicate and beautiful cancellation is thus made which, however, can scarcely be seen without the aid of a lens. Inner margin crenulate; the ribs of the exterior are more or less visible in the interior of the shell; hinge delicate but teeth very distinct.

Length of largest shell 9 ; height 7 ; diameter of one valve 2 mm. The usual size is, however, much smaller.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

This very elegant species resembles *C. magnoliana* Dall from the Upper Miocene of Magnolia, North Carolina, but the Chipola species can be distinguished at a glance by its much more inequilateral form.

Phacoides prunoides, n. s.

Pl. IX, fig. 3.

Shell resembling *P. prunus* Dall of the Miocene of Maryland but more inequilateral, with a decided sulcus extending from the beak to the margin of the shell, and with more recurved beaks. Concentric sculpture of regular, low, flat-topped ribs with very narrow inter-spaces ; inner margin of shell finely crenulated.

Height of shell 7 ; length 7.5 ; diameter 4 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Phacoides actinoides, n. s.

Pl. IX, fig. 4.

Shell resembling *P. actinus* Dall from the Oligocene of Bowden, Jamaica but larger, more inequilateral, and with more strongly recurved beaks than that species from which it also differs in sculpture. The Oak Grove species is a plump, fairly solid shell, with the anterior end longer than the posterior but compressed as though pinched, lunule cordate, distinct ; shell with three types of sculpture viz : very near the beak are about three concentric lamellæ which form the only sculpture for a distance of about half a millimeter ; beyond this radial ribs begin to appear and form with the succeeding half-dozen concentric lamellæ a beautiful cancellation like that over the whole disc of the Pliocene *P. waccamawensis* Dall. This cancellation continues for a distance of about one millimeter after which the concentric lamellæ become fainter and more irregular and the six or seven primary ribs continue only faintly to the ventral margin of the

shell; a large number of interstitial, radial lines appear (about 32 at the margin of the shell) and cover the larger part of the disc replacing the earlier cancellation. It is an interesting fact that this species began, but almost immediately abandoned, the style of ornamentation which in the Miocene and Pliocene became so characteristic of shells of the *Bellucina* type. Hinge with well developed teeth; inner margin of shell finely crenulated

Length of shell 7; height 6.5; diameter of one valve 2 mm.

Oak Grove, Santa Rose County, Florida.

Cornell University collection.

Phacoides (*Bellucina*) *nereidideditus*, n. s.

Pl. IX, fig. 5.

Shell nearly circular, small, resembling *P. waccamawensis* Dall from the Pliocene of South Carolina and Florida, but smaller, more alate and with an additional set of fine radiating riblets which alternate with the series of broad ribs similar to those of *waccamawensis*. Hinge strong, teeth well-developed, interior fluted by the exterior ribs, inner margin finely and rather deeply crenulated.

Length of the single specimen found 4; height 4 mm.

Oak Grove, Florida.

Cornell University collection.

Bornia fluctusculpturata, n. s.

Pl. IX, fig. 6.

Shell oval-trigonal, very thin and fragile, translucent, exquisitely sculptured near either end with many radiating plications like wavelets which are also apparent on the inside of the shell. They do not extend over the center of the valves. Under a lens the lines of growth are seen forming a most delicate concentric ornamentation over the entire shell on the inner as well as the outer side of the valve. Hinge very like that of *Bornia dodona* Dall from Oak Grove and sculpture of the same type as that of *B. scintillata* Dall from the Claiborne Eocene, but the plications are closer in that species and extend over the ventral

margin of the shell. Length of largest specimen (imperfect)9 ; altitude 6 mm ; length of younger specimen (complete) drawn 6 ; altitude 4 mm.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Pitaria (Lamelliconcha) Harrisi, n. s.

Pl. IX, fig. 7.

Shell nearly orbicular, slightly compressed and inequilateral, with regular, close, concentric ribs ; beaks not prominent ; lunule rather small, well-defined, cordate ; anterior end rounded ; posterior bluntly angulated ; base either rounded or in some specimens slightly angulated ; hinge strong, the anterior laterals and the cardinals well developed ; pallial sinus deep, ascending, triangular, reaching to the middle of the shell. Length of largest specimen 16.5 ; height 15 ; diameter of one valve 3 mm. The usual size is, however, much smaller.

This species resembles in general form and sculpture *P. imitabilis* Conrad, but the shell is smaller and the ribbing closer.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

Semele perlamelloides, n. s.

Pl. IX, fig. 8.

Shell thin, oval-orbicular, equilateral ; beaks low, very acute ; dentition and interior of shell concealed by the matrix ; surface with close-set, regular, raised concentric lamellæ ; slightly angulated on the posterior slope. Length 38 ; height 30 ; diameter 12 mm.

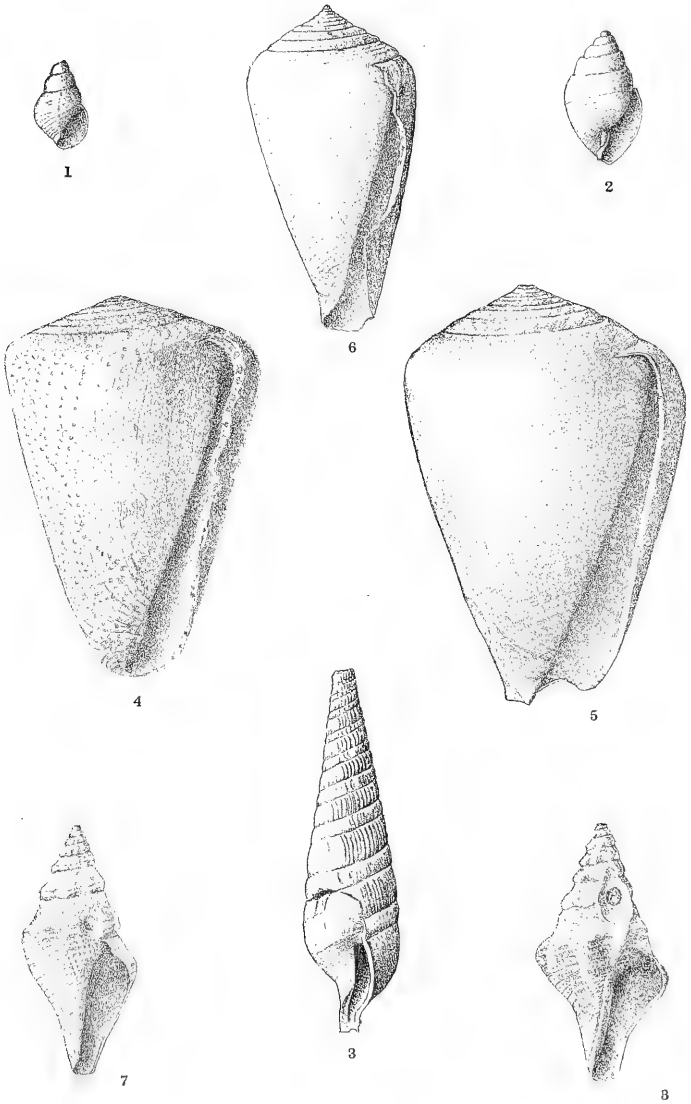
This shell resembles closely *S. perlamellosa* Heilprin from the Pliocene of the Caloosahatchie, but is proportionally shorter and higher than that species of which it is no doubt the ancestral form.

Chipola marls, Bailey's Ferry, Florida.

Cornell University collection.

EXPLANATION OF PLATES

PLATE I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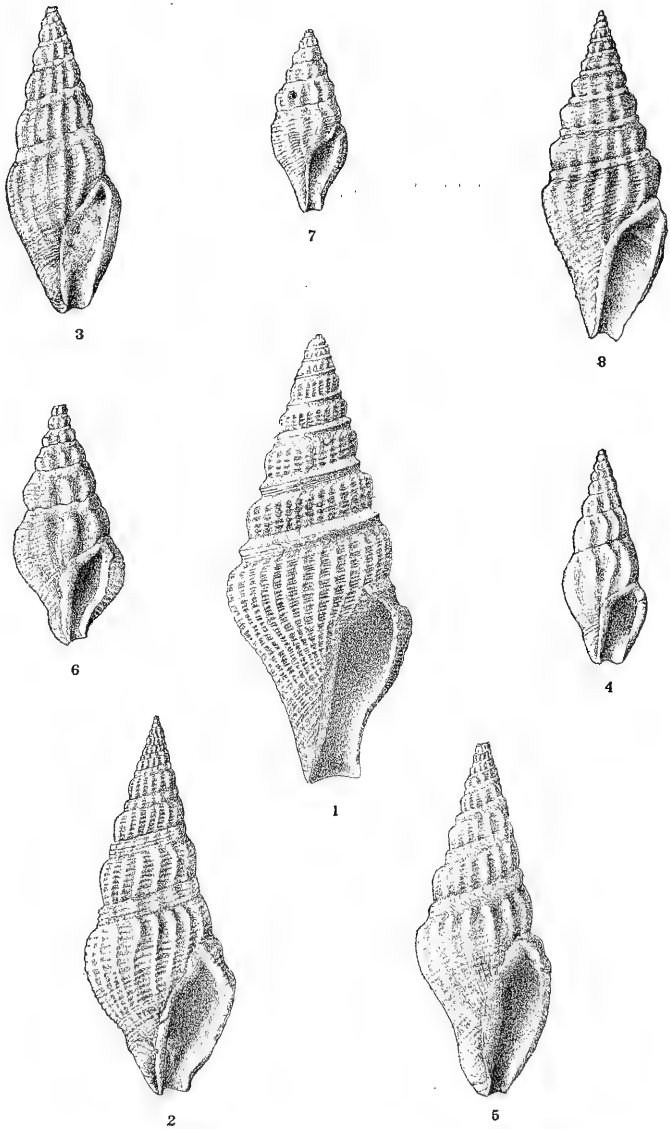
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PLATE II

PLATE III

			Page
Fig.	1.	Mangilia Clarœ. 6.5 mm. Bailey's Ferry	11
	2.	" Websteri. Length 8 mm. Bailey's Ferry	11
	3.	" Isabellæ. 5 mm. Bailey's Ferry	11
	4.	" nemorensis. 4 mm. Oak Grove	12
	5.	" Ramondi. 5 mm. " "	12
	6.	" Strabonis. 4 5 mm. " "	12
	7.	" Tarri. 6 mm. " "	13
	8.	Clathurella nemorensis, 4.5 mm. " "	13
	9.	Glyphostoma Aldrichi. 7 mm. " "	14
	10.	" Harrisi. 20 mm. Bailey's Ferry	14

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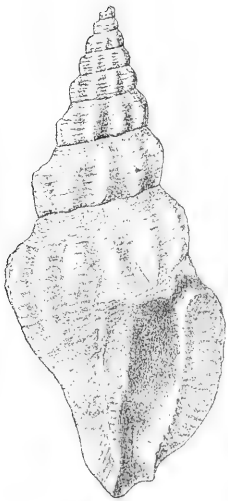

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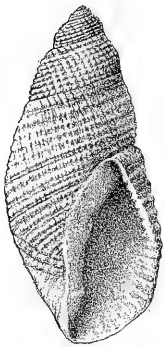

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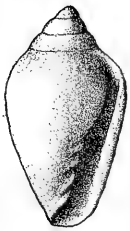

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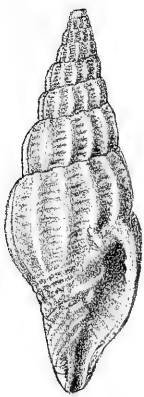

9

PLATE IV

PLATE V

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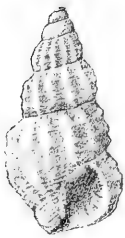

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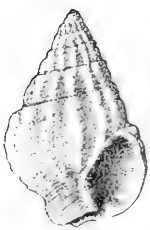

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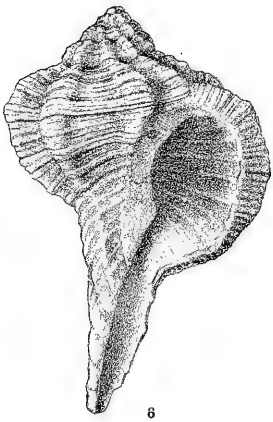

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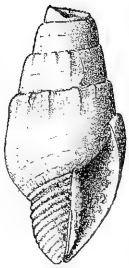

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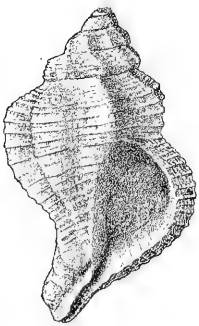

7

8

5

PLATE VI

PLATE VII

			Page
Fig.	1.	Rimella Aldrichi. Length 12 mm. Oak Grove	27
	2.	Bittium Judsoni. 4 mm. Oak Grove	27
	3.	Cerithiopsis Ogilvies. 11 mm. Oak Grove and Bailey's Ferry	27
	4.	Isapis Myttonis. 8 mm. Bailey's Ferry	28
	5.	Litiopa palæosargassina. 5 mm. Oak Grove	28
	6.	Natica Judsoni. 18 mm. Oak Grove	29
	7.	Adeorbis Aldrichi. Diameter 1 mm. Oak Grove	29
	8.	Scala Virginiæ. Length 3.75 mm. Bailey's Ferry	29
	9.	Eulima chipolana. Length 9 mm. " "	30
	10.	" parasitos. 4 mm. Oak Grove	30
	11.	" nemoralis. 3 mm. " "	30
	12.	" Scotti. 8.5 mm. Bailey's Ferry	30

1

3

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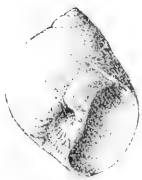
8

4



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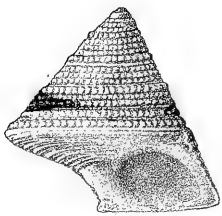

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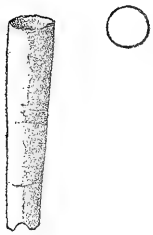

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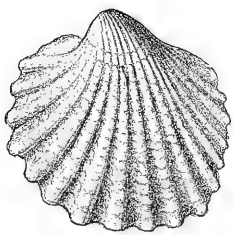

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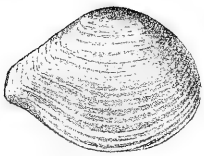
5

PLATE VIII

PLATE IX



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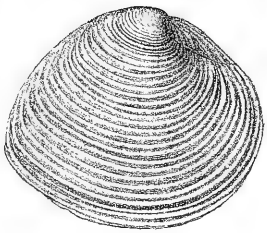

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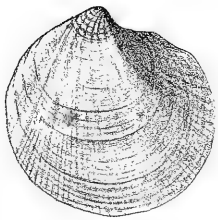

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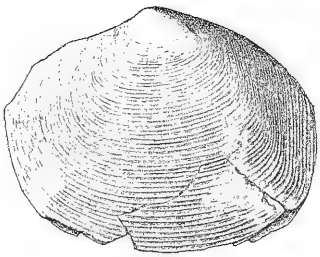

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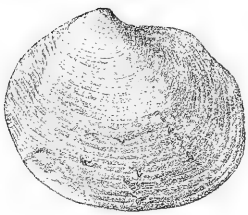

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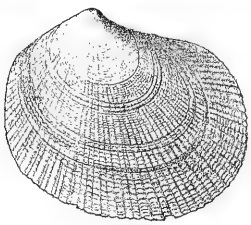

2

INDEX

VOL. IV.

N. B.—The numerals refer to the continuous paging and plate numbering of the Volume, not of the separate Bulletins.