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BLACK RIVER STRATIGRAPHY AND FAUNAS.

PART II.

FREDERICK PENTZ YOUNG, JR.

THE CHAUMONT FORMATION.

Stratigraphy of the Chaumont Formation.

The Chaumont limestone[45] taking its name from Chaumont Bay, Jefferson County, New York, has been defined as "including beds younger than the Lowville and older than the Rockland in this region." It consists of three members, which are, in ascending order, the Leray limestone, the Glenburnie shale, and the Watertown limestone.

Leray Limestone. The term Leray,[46] from the township of Leray, Jefferson County, New York, was originally applied to about 13 feet of limestone which were considered to constitute the top member of the Lowville formation. In this region, these beds are made up of dark brownish-gray or black, rather fine-textured, hackly fracturing, semi-crystalline limestone containing much black chert. This chert is usually in the form of flattened nodular masses distributed along bedding planes, but occasionally found as veins traversing the stratification. The Leray forms thick beds separated by distinct partings, along which there are often conspicuous re-entrants. On a fresh surface the limestone appears very massive, but upon long weathering breaks up into small irregular blocks.

Glenburnie Shale. The Glenburnie[47] is two feet of highly fossiliferous, shaly limestone described as having a position stratigraphically between the Leray and Watertown limestones.

[45] Kay, G. M.: 1929, Stratigraphy of the Decorah formation. Jour. Geol., Vol. 37, p. 664.

[46] Cushing, H. P., Ruedemann, R., and others. op. cit., pp. 84-85.

[47] Kay, G. M., op. cit., pp. 664-665.

The type locality is near the hamlet of Glenburnie, in Kingston Township, Frontenac County, Ontario.

Watertown Limestone. In the vicinity of Watertown, Jefferson County, New York, and especially well shown along Black River, there are 13 feet of massive limestones overlying the Leray. The upper seven feet form a nearly single wall. This is the old "seven-foot tier" of quarry-men and the "Black River limestone" of James Hall. Because of similarity in lithology and fauna, Cushing and Ruedemann[48] combined this tier with the six feet of beds beneath, and named the whole "Watertown limestone." In the type area it thus appears as two very thick ledges of dark gray to black, fine-textured, hackly fracturing, semi-crystalline limestone. In general, the Watertown is here distinguished lithologically from the Leray by the dearth of chert in the former, although the lower six feet have some. The upper portion is exceedingly petroliferous. The whole member exhibits the same blocky weathering shown by the Leray.

Cushing and Ruedemann[49] describe the section at Klock's quarry, Huntington and Clinton streets, on the south bank of Black River in the eastern part of Watertown. Overlying the "Seven-foot tier" at this locality are two feet of dark gray, fine-textured, irregularly laminated, petroliferous limestone,[50] which they referred to the Watertown. The writer has found that a thickness of at least four feet of these beds is well-exposed on Diamond Island, which lies in Black River opposite Klock's quarry. Their fauna is that of the Selby member of the Rockland (lowest Trenton) as described by Kay[51] at the quarry two miles east of Dexter. This locality is about seven miles west-northwest of Diamond Island. It appears, then, that the two feet of beds overlying the "Seven-foot tier" at Klock's quarry are Trenton and not Chaumont in age.

When many sections of the upper Black River beds have been studied, the value of the term "Chaumont" becomes apparent. The Watertown and Leray members are not lithologically distinguishable except in the type area. Black chert is usually much more common in the lower beds (Leray) in New York,

[48] Cushing, H. P., Ruedemann, R., and others. op. cit., pp. 84-87.
[49] Ibid., p. 90.
[50] Ibid., pp. 86-87.
[51] Kay, G. M.: 1937, Stratigraphy of the Trenton group. Geol. Soc. Amer., Bull. Vol. 48, p. 253.

but even in Jefferson County is not consistently so, and in southern Ontario is equally abundant in the upper beds. Other, more striking lithologic changes make correlation difficult. These will be discussed in connection with the distribution of the Chaumont and the various sections.

In attempting to correlate the Leray and Watertown members with possibly equivalent beds in southern Ontario, it has been helpful to consider metabentonite partings. Kay[52] has described metabentonitic clays in the Glenburnie member of the Chaumont in Kingston Township, Ontario, and in the Selby[53] member of the Rockland near Dexter, New York. Some of the more persistent partings within the Chaumont may have developed along such thin metabentonite horizons.

Distribution of the Chaumont Formation.

In the northwestern New York area, the Chaumont reaches maximum thickness in the Watertown district. More resistant than the underlying Lowville and the overlying, thin-bedded Trenton, it forms a plateau about five miles in width, usually bounded by a steep escarpment. In addition to the nearly continuous outcrops along Black River, excellent sections are seen in the large quarries at Pamelia station, two miles southeast of Watertown, which show about 26 feet of Chaumont, in the present town quarry about two miles north of Watertown on U. S. route 11, and in the quarries near Chaumont. Wherever the contact with underlying beds may be seen in this district and elsewhere, the Chaumont lies upon the Lowville. Cushing[54] states that there is an unconformity between these formations. In general, the relation appears to be conformable, but there are localities where there appears to be a disconformity. In Jefferson County, the Chaumont is overlain by the Selby member of the Trenton Rockland.

From this region southeastward along the Black River Valley, the Chaumont thins rather rapidly and forms a comparatively narrow belt from a tenth to a half of a mile in width, but caps a conspicuous terrace along the west side of the valley. At Lowville, Lewis County, the top of this terrace lies at about

[52] Kay, G. M.: 1930, Age of the Hounsfield bentonite. Science, Vol. 72, p. 365, Oct. 10.

[53] Kay, G. M.: 1935, Distribution of Ordovician altered volcanic materials and related clays. Geol. Soc. Amer., Bull., Vol. 46, pp. 229-230.

[54] Cushing, H. P., Ruedemann, R., and others. op. cit., p. 85.

860 feet in elevation and 100 feet above the valley floor. The fine section along Mill Creek in Lowville reveals 13 feet of Chaumont beneath 14 feet eight inches of cherty beds, which Kay[55] has identified as Selby.

At Roaring Brook, East Martinsburg, about four miles south of Lowville the Chaumont has thinned to nine feet five inches, but has much areal exposure containing the characteristic cephalopods. It is doubtfully overlain here by the Selby, which member has not been recognized south of this point in the Black River Valley.[56]

Along Sugar River and in old quarries one mile south of Denley Station, Lewis County, there are nine feet seven inches of Chaumont exposed. At Newport, Herkimer County, several feet of beds overlying the Lowville have been referred to the "Black River" by Raymond.[57] Recent work by Craig[58] has shown them to be of Trenton age. Kay[59] had previously noted that they appeared to be Selby. At Middleville, Herkimer County, about five miles to the southeast, the Chaumont is also absent; the Hull[60] formation of the Trenton lies directly upon the Lowville. It is missing at Ingham Mills, Herkimer County, where the Rockland[61] overlies the Lowville, although "Black River" was once thought to be present.[62]

As the Chaumont formation thins southward through the Black River Valley, both Leray and Watertown members may be present, and thin concomitantly. In Jefferson County, the Watertown shows the characteristic cephalopods in much greater profusion than does the underlying Leray. At many points, notably at Deer River and at Roaring Brook, where the total thicknesses of the Chaumont are five feet eight inches and

[55] Kay, G. M.: 1937, Stratigraphy of the Trenton group. Geol. Soc. Amer., Bull., Vol. 48, p. 253.

[56] Ibid., p. 254.

[57] Raymond, P. E.: 1903, The Faunas of the Trenton at the type section and at Newport, N. Y., Bull. Amer. Paleont., No. 17, pp. 14-17.

[58] Craig, L. C.: 1941, Lower Mohawkian stratigraphy of central New York State. Columbia University, Dept. of Geology, M. A. thesis, p. 11.

[59] Kay, G. M.: op. cit., p. 255.

[60] Kay, G. M.: 1935, Distribution of Ordovician altered volcanic materials and related clays. Geol. Soc. Amer., Bull., Vol. 46, p. 230.

[61] Kay, G. M.: 1937, Stratigraphy of the Trenton group. Geol. Soc. Amer., Bull., Vol. 48, p. 255.

[62] Prosser, C. S.: 1900, Notes on the stratigraphy of the Mohawk Valley and Saratoga County. N. Y. State Mus., Bull., 34, p. 469.

Cushing, H. P.: 1905, Geology of the vicinity of Little Falls, Herkimer County, New York. N. Y. State Mus., Bull., 77, p. 31.

nine feet five inches respectively, the cephalopods are very numerous in the upper beds.

More interesting stratigraphic problems develop when one attempts to trace the Chaumont across the St. Lawrence River into southern Ontario.

Kindle[63] has noted that in the Kingston, Ontario, area the "Watertown is not distinguishable" and that "the cherty beds said to characterize the Leray on the New York side of the river are absent or very slightly developed." He states that it is "convenient to treat the Leray and Lowville in this area as a single lithologic unit." Although there certainly is difficulty in distinguishing the Watertown and Leray in the general area, it does not seem necessary to lump the Leray and Lowville.

On Wolfe Island, Frontenac County, Ontario, there are good exposures in a quarry about half a mile northeast of Marysville, on the northwestern side of the island, about three and one-half miles from Kingston, where ten feet of Chaumont overlie some seven feet of Lowville, and the two formations are distinguished rather easily. The lower part of the Chaumont is a massive, three foot ledge; above this are four feet of somewhat thinner beds with Chaumont lithology, and then one foot of shaly beds. In the remaining several feet of beds, an horizon of typical Chaumont black chert was noted. The shaly beds here are the easternmost indication of a lithologic facies which becomes more common going westward in Ontario. They occupy about the same stratigraphic position as the Glenburnie shale, the type locality of which lies nine miles to the northwest, but they are unfossiliferous. Kay has described the Glenburnie shale as having a position between the Leray and Watertown members, and has listed its fauna. Ulrich[64] had previously identified this fauna, and apparently confused the beds with the Selby member of the Rockland as found in northwestern New York. He stated that "the same zone is thinly represented at Watertown and Threemile Bay, in New York, but there it is separated from the Lowville by the Watertown limestone." Inasmuch as *Tetradium cellulosum* and Lowville lithologies extend upward to an horizon six feet below the Glenburnie, it appears that not all of the eight feet six inches of beds below the Glenburnie shale in the type quarry are Leray,

[63] Kindle, E. M.: op cit., p. 42.

[64] Ulrich, E. O.: letter to E. M. Kindle in: Kindle, E. M.: op. cit., p. 43.

as described by Kay, but only the upper six feet, the lower two feet six inches being Lowville.

As sections are studied westward from the Kingston area, there are several generalizations which may be made. On the whole, there is less distinction lithologically between the Lowville and Chaumont, although the faunal differences are persistent. Instead of being concentrated in the lower beds, as it is in New York, black chert may be entirely absent, scattered through the formation, or confined to the upper part. In every section observed in Ontario, there are some ledges as massive as those characteristic of the Chaumont in the Watertown area, but the formation tends to be thinner-bedded, more argillaceous, and often finer-textured. In Ontario, it also is browner, especially when a fresh surface is wet.

Excellent sections may be seen at Napanee, Lennox and Addington County, and at Sharps Corners, about six miles to the north. At Napanee 16 feet, and at Sharps Corners 21 feet of Chaumont are exposed. Thirty inch shaly beds containing metabentonite partings are present 12 and 14 feet respectively above the base of the Chaumont at these localities. They may be tentatively correlated with the metabentonite-bearing Glenburnie shale, the type locality of which lies some 24 miles to the east. No chert has been noticed in the Napanee area. The Selby[65] member of the basal Trenton, which has its type locality close to Napanee, is apparently not present in the localities mentioned, but is the overlying rock in much of this district.

At Crookston, Hastings County, the Chaumont is 23 feet seven inches thick. Black chert is common in the upper part, and there is a one foot bed of fossiliferous shale at 15 feet in the section which may be equivalent to the above-mentioned shales at Sharps Corners and Napanee. There are eight feet six inches of overlying Selby at this point.

In the Watertown area there are fairly persistent prominent partings at about seven feet and 13 feet six inches above the base of the Chaumont. It is believed that these, among others, may have developed along thin metabentonite horizons, as previously mentioned. The parting at 13 feet six inches coincides with the top of the Leray. Kay[66] has suggested that this

[65] Kay, G. M.: op cit., p. 252.

[66] Kay, G. M.: 1929, Stratigraphy of the Decorah formation. Jour. Geol., Vol. 37, p. 664.

horizon is represented in Ontario by the Glenburnie shale containing its metabentonite. It seems reasonable that this parting may also be indicated by the partings in shaly beds 12 feet above the base at Napanee, 14 feet at Sharps Corners, and 15 feet at Crookston. The partings at about seven feet in New York may be represented by those at six feet four inches at Sharps Corners, six feet one inch at Crookston, six feet at Marmora, Hastings County, and six feet at Crow Bridge, Northumberland County.

In the large quarries of the Canada Lime Company at Point Anne, three miles east of Belleville, Hastings County, there are 43 feet of Chaumont overlying six feet of exposed Lowville. This is the greatest thickness of the formation so far found. Near the top of the section there are a few feet of light brown, sublithographic limestones. This facies becomes increasingly important westward in Ontario.

At Marmora, Hastings County, there are 13 feet of the formation exposed. Black chert is abundant. The brownish gray or brown, sublithographic limestones appear at several horizons, and would be difficult to distinguish from Lowville, were it not for the presence of typical Chaumont cephalopods and other fossils.

A better section is found at Crow Bridge, Northumberland County, about eight miles southwest of Marmora. Here some 21 feet of Chaumont are exposed, some of it showing the brown, sublithographic beds, as at Marmora, and other beds shaly and highly fossiliferous. With good exposures at Warsaw and Youngs Point, Peterborough County, the formation retains essentially the same lithology and a maximum thickness of about 25 feet to a point north of Peterborough, and then thins to 12 feet in the Lake Simcoe area.

Chaumont of the Ottawa and St. Lawrence Valleys, and East of the Adirondacks. There has been confusion in the use of the term "Leray," especially in the Ottawa district. Wilson,[67] in describing the Rockland at the type section at Rockland, Ontario, has called "Leray" some 18 feet of beds between the Lowville and the Trenton Rockland. Kay[68] has shown that some of these beds are properly classified as Selby. In the

[67] Wilson, A. E.: 1921, The range of certain lower Ordovician faunas of the Ottawa Valley. Geol. Survey Canada, Bull. 33, p. 26.

[68] Kay, G. M.: 1937, Stratigraphy of the Trenton group. Geol. Soc. Amer., Bull. Vol. 48, pp. 252-255.

vicinity of Ottawa, the Chaumont is 12 feet thick. It also appears that beds at Pauquette Rapids, at the east end of Allumette Island, Quebec, which have been called "Leray," are equivalent to the Rockland Cloche Island limestone.

A section has been studied at the Fourth Chute of the Bonnechere River, east of Eganville, Ontario, which seems to have 49 feet of beds with characteristic Chaumont fauna.

Okulitch[69] has stated that the Leray has a thickness of 23 feet in the vicinity of Montreal, Quebec, and that it is present in the St. Lawrence Valley between Montreal and Quebec[70] possibly as far east as St. Anne River, about 35 miles southwest of Quebec City. At Crown Point, on the western shore of Lake Champlain, the Chaumont is represented by 27 feet of limestone overlying the Lowville and underlying the Trenton Amsterdam limestone.

Facies of the Chaumont Formation.

In New York, the Chaumont has two rather distinct facies, the massive limestones with chert which compose the Leray, and similar limestones with little or no chert making up the Watertown.

The Leray, or lower member, consists of dark gray to black, fine and moderately fine, hackly fracturing, semi-crystalline limestone, with argillaceous seams and much black chert. This member and the overlying Watertown have thick massive beds separated by distinct partings, which may have in some cases developed at metabentonite beds.

The Watertown member is lithologically rather similar to the lower member, except that it tends to be slightly finer-textured, to lack black chert, and to be more petroliferous.

In general, these massive beds of the Chaumont tend to be of purer limestone than most horizons of the Pamelia and Lowville. The facies is characteristic of the formation well into central Ontario, although other facies assert themselves. The analysis[71] of a sample from Crookston, Ontario, which represents the entire face of the quarry there except for the top

[69] Okulitch, V. J.: 1936, The Black River group in the vicinity of Montreal. Geol. Survey Canada, Mem. 202, Pt. 4, p. 129.

[70] Okulitch, V. J.: 1939, The Black River group in the region between Montreal and Quebec. Amer. Jour. Sci., Vol. 237, p. 81.

[71] Goudge, M. F.: 1938, Limestones of Canada, their occurrence and characteristics. Pt. 4, Ontario. Canada Bur. Mines, Publ. 781, p. 109.

chert beds, shows the high $CaCO_3$ content and generally pure nature of these beds: SiO_2 2.08; Fe_2O_3 .27; Al_2O_3 .43; $CaCO_3$ 95.52; $MgCO_3$ .88; Calcium phosphate .02.

As previously described, the black cherts are in the form of irregular nodular masses, flattened parallel to bedding planes, and often forming distinct horizons of partly continuous chert where they are abundant. Thin chert veins are also present in some sections. Although most of the fossils of the Chaumont, especially in New York, have been silicified, there seems to be no definite relation between the chert nodules and fossils now present. Most of the well silicified fossils of the upper Chaumont of New York are not in contact with chert, whereas in other parts of the formation fossils are incorporated within chert nodules. The relationship appears to be accidental. It seems likely that the chert was probably penecontemporaneous in origin. During diagenesis, silica was redistributed in the sediments, some of it replacing shells, and some of it being concentrated in larger masses along bedding planes. The veins must be much later deposition of silica along joint planes, long after the transformation of the calcareous mud to limestone had been completed. It may be that the distribution of the chert stratigraphically and geographically can be explained by a consideration of the relation between Chaumont shorelines and the present occurrence of the members. If streams brought the silica into the seas, it would be expectable to find more chert toward the shoreward margin of a facies, and especially opposite the mouths of the larger rivers. This may explain the fact that in southern Ontario, beds very similar lithologically to the Chaumont near Watertown, lack chert. On this same basis, the Watertown facies, with scarcely any chert, may represent more open-sea conditions, and may once have been much more extensive areally than the present distribution of outcrop would indicate.

The facies described seem to indicate that normal marine conditions existed in the area, and that the sea was deeper than it had been in upper Lowville time, which is represented largely by the fine-textured, chemical precipitates.

Metabentonite beds that were responsible for the more persistent partings in the Chaumont, must have been deposited as ash beds beneath the sea.

In southeastern Ontario, some of the Chaumont tends to be more argillaceous than in New York, and this is responsible for

thinner, less massive beds. Definitely shaly limestones, or actual shales, appear as far east as Wolfe Island, but are most apparent at Glenburnie, Napanee, Sharps Corners, Crookston, and Crow Bridge. This facies is usually highly fossiliferous, and yields a large marine fauna. Where it is most argillaceous and muddy, bryozoa, ostracodes, gastropods, cephalopods, trilobites, and pelecypods are dominant. Where the shales are more calcareous, they contain corals and more brachiopods, animals which apparently preferred clearer waters. These shaly facies seem to be of rather local distribution, and probably indicate deposition in embayments along shore, or about islands in the Chaumont sea.

As previously mentioned, the Chaumont at Marmora, Point Anne, Crow Bridge, and other localities, has interbedded with more typical massive lithologies, beds of gray and brownish gray, sublithographic limestones similar to those of the Lowville and Pamelia. Unlike those in the older formations, these fine limestones contain black chert at several horizons. They are rather poor in fossils, although they do contain at Marmora such characteristic Chaumont forms as *Columnaria*, *Stromatocerium*, *Actinoceras*, *Rhynchotrema*, and *Strophomena*. It is believed that these beds were deposited in quiet, shallow water, where there was considerable chemical precipitation of carbonates.

History of the Chaumont Formation.

Cushing[72] has stated that the Chaumont lies unconformably on the Lowville. In most places, the formations appear to be conformable, but it has been noticed that in some areas the upper beds of the Lowville are quite different in lithology and thickness from place to place, where they are in contact with the Chaumont. This would seem to indicate that the relationship is a disconformity in some districts. There may have been localized uplift of the area which had been covered in Lowville time, before the invasion of the Chaumont sea.

In the foregoing discussion of facies, it has been found that the massive, medium-textured, semi-crystalline, marine limestones are most characteristic of the Chaumont in northwestern New York and southeastern Ontario. This would indicate that as the Chaumont sea overlapped, the eastern end of the Ontario

[72] Cushing, H. P., Ruedemann, R., and others. op. cit., p. 85.

basin was the general location of typical marine conditions, that submergence was at a maximum here. It is likely that the inland sea overlapped northeastward, just as it had done in Pamelia time, the axis of the embayment running through northwestern New York.

There are various facts which suggest that Chaumont deposition took place in a sea more extensive than the Lowville sea had been. In the first place, there is the wide geographic distribution of Chaumont outcrop, from Lake Champlain to St. Joseph Island. Then there is the fact that the formation overlaps the Lowville at Shannonville, Hastings County, where there is one of the conspicuous Pre-Cambrian knobs previously mentioned, and on St. Joseph Island. Most of the Chaumont consists of more typical marine facies than does the Lowville.

The fact that the lower Trenton formations overlap the Chaumont and lie directly upon the Lowville, as at Middleville and Ingham Mills, New York, is believed due to erosion of Chaumont beds following a retreat of marine waters at the close of Chaumont time, and before the very extensive marine invasion of the Trenton sea.

BLACK RIVER SECTION AT LOWVILLE, NEW YORK.

(Number 43 on Geologic Map).

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Including beds in:				
(a) Quarry just east of railroad bridge, and north of road running along north side of Mill Creek				
(b) Exposures along Mill Creek				
(c) Quarry in eastern Lowville. South side of Mill Creek				
Overlying beds composed of Trenton–Selby member	14	8	..	..
Chaumont Formation				
Dark gray, fine, massive cherty limestone. Many large chert nodules at top, and some 11″ above base. *Columnaria halli* Nicholson near base	4	5	79	10
Medium gray, fine, massive cherty limestone, with prominent parting 5′ above the base, and chert 23″ above the base. Conspicuous silicified coquina 5′ 9″ above the base. *Rafinesquina clara*				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Okulitch, *Leptaena radialis* Okulitch, *Hesperorthis sp.*, *Lambeophyllum profundum* (Conrad), *Cycloceras romingeri* Foerste, *Orthoceras sp.*, *Bythocypris sp.*, *Leperditia fabulites* (Conrad), *Stromatocerium rugosum* Hall	8	10	75	5
Lowville Formation				
Dark gray, fine, granular limestone forming prominent re-entrant	..	1	66	7
Medium gray, white-weathering, sublithographic limestone, in thick beds. Many gastropods in upper half; much *Phytopsis* in lower. *Isochilina sp.*	1	..	66	6
Same as above, but thinner-bedded, with uneven shaly parting	..	7	65	6
Medium gray, white-weathering, massive sublithographic limestone. *Phytopsis* throughout. Gastropods	1	10	64	11
Dark gray-black, massive, sublithographic limestone. *Orthoceras multicameratum* Emmons, *Zygospira recurvirostris* (Hall), *Trochonema sp.*, *Aparchites sp.*	3	3	63	1
Dark gray-black, moderately fine, unevenly bedded argillaceous limestone full of *Tetradium cellulosum* (Hall). *Trochonema umbilicatum* Hall, *Orthoceras multicameratum* Emmons	4	9	59	10
Undulating contact.				
Dark gray, fine, unevenly bedded argillaceous limestone. *Strophomena sp.*, *Illaenus sp.*	..	5	55	1
Massive, white-weathering, sublithographic limestone; light gray at top, becoming dark gray-black towards the base. Some *Tetradium cellulosum* (Hall) in upper half. Bryozoa common at base. *Zygospira recurvirostris* (Hall)	1	11	54	8
Dark gray and white, unevenly bedded, argillaceous and semi-crystalline limestone, weathering light gray. Much white calcite in gastropods and pelecypods. *Cyrtodonta huronensis* Billings, *Tetradium cellulosum* (Hall)	..	10	52	9
Fairly prominent undulating contact.				
Dark, gray-black, moderately fine semi-crystalline limestone, weathering light gray. *Orthoceras multicameratum* Emmons. Gastropods	..	5	51	11
Undulating argillaceous contact.				
Black sublithographic limestone, weathering light gray. *Tetradium cellulosum* (Hall), trilobite, gastropods	..	3	51	6
Prominent straight contact.				
Dark gray, massive sublithographic limestone with bands of medium textured semi-crystalline				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
limestone. *Phytopsis, Bathyurus extans* (Hall), *Hormotoma gracilis* (Hall), *Holopea sp., Isochilina sp., Aparchites sp.*	..	8	51	3
Prominent re-entrant.				
Dark gray, massive, white-weathering, sublithographic limestone, with argillaceous partings. *Phytopsis* throughout. *Orthoceras multicameratum* Emmons	3	10	50	7
Medium gray, medium, semi-crystalline or granular, thin-bedded limestone, forming wide re-entrant. *Strophomena sp., Orthoceras sp.*	..	10	46	9
Prominent undulating parting.				
Medium gray, sublithographic and medium semi-crystalline limestone	..	7	45	11
Prominent undulating parting, and floor of quarry (a).				
Medium gray, moderately fine, semi-crystalline and granular limestone. Sublithographic in upper few inches	1	7	45	4
Distinct plane parting.				
Dark gray, fine, massive semi-crystalline and saccharoidal limestone with much white calcite. Lower 32″ weathers with pitted and lumpy surface	3	8	43	9
Prominent undulating contact.				
Dark gray, fine, thin-bedded semi-crystalline and argillaceous limestone, weathering shaly	2	..	40	1
Prominent undulating parting and re-entrant.				
Medium grey, medium massive oolitic limestone with limestone pebbles. *Cycloceras decrescens* (Billings), *Cyrtodonta huronensis* Billings, *Orthoceras multicameratum* Emmons	1	2	38	1
Prominent parting and small re-entrant.				
Medium gray, medium granular limestone. Upper part more massive and fossiliferous; lower part thinner-bedded. *Bathyurus extans* (Hall), *Isotelus sp., Helicotoma sp., Isochilina armata* Walcott, *Orthoceras sp.*	1	..	36	11
Undulating contact.				
Dark gray-black, fine and moderately fine, semi-crystalline limestone, with limestone pebbles and much white calcite. *Trochonema umbilicatum* Hall. Large lensing masses	1	10	35	11
Dark gray, fine, massive, semi-crystalline limestone, with many limestone pebbles, and weathering spotty yellowish	..	11	34	1
Prominent undulating re-entrant.				
Dark gray, moderately fine, unevenly bedded, argillaceous and semi-crystalline limestone, with many limestone pebbles and much white calcite. *Trochonema umbilicatum* Hall, *Isochilina armata*				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Walcott, brachiopods, trilobites, bryozoa ..... Prominent, fairly straight re-entrant.	..	7	33	2
Pamelia Formation				
Medium to dark gray, fine, massive, semi-crystalline limestone, with pinkish blotches ..... Prominent parting.	2	..	32	7
Medium gray, fine, thin-bedded, semi-crystalline limestone	..	5	30	7
Medium to dark gray, sublithographic and moderately fine semi-crystalline limestone, with patches of white calcite	1	10	30	2
Medium gray, fine and medium argillaceous limestone, weathering shaly. A 2″ bed with limestone pebbles in middle. *Tetradium sp.*, trilobites, brachiopods, bryozoa ..... Prominent parting.	1	7	28	4
Dark gray, massive, flinty sublithographic limestone ..... Prominent shaly parting.	..	9	26	9
Medium gray, moderately fine and medium, saccharoidal, granular and semi-crystalline limestones in alternating beds, with argillaceous partings ..... Prominent parting and floor of quarry (c).	5	..	26	..
Dark gray, massive, stylolitic, sublithographic limestone. *Tetradium syringoporoides* Ulrich abundant at top ..... Prominent parting.	1	11	21	..
Medium gray, sublithographic and saccharoidal, rather thin-bedded limestone ..... Prominent parting.	1	5	19	1
Medium bluish gray, fine, thin-bedded granular and saccharoidal limestone. 4″ massive bed at base	2	9	17	8
Moderately dark gray, thin-bedded sublithographic and saccharoidal limestones. Much white calcite in patches and stringers ..... Prominent parting and re-entrant.	2	4	14	11
Dark gray, massive sublithographic stylolitic limestone ..... Prominent undulating parting.	..	10	12	7
Dark gray, thin-bedded sublithographic limestone with argillaceous seams	1	..	11	9
Dark gray, massive sublithographic limestone with calcite in patches and stringers. Constitutes bottom of exposures across Mill Creek from quarry (c)	2	..	10	9
Medium gray, massive saccharoidal and semi-crystalline limestone. Much white calcite	..	10	8	9
Medium gray, fine, thin-bedded, saccharoidal and semi-crystalline limestone	1	4	7	11

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Medium gray, fine, massive saccharoidal and semi-crystalline limestone	1	..	6	7
No exposures for about 100 yards. Several feet of beds concealed. Beds below are exposed just west of small road bridge over Mill Creek in east Lowville.				
Medium gray, fine, massive, stylolitic, flinty semi-crystalline limestone	1	1	5	7
Medium gray, fine, massive argillaceous limestone	..	9	4	6
Prominent parting.				
Medium gray, fine, thin-bedded, flinty semi-crystalline limestone	..	5	3	9
Prominent parting.				
Light, bluish gray (with yellowish blotches), fine, thin and unevenly bedded saccharoidal limestone, weathering yellowish gray	2	1	3	4
Prominent parting.				
Medium gray, fine, massive limestone, weathering yellow brown	1	3	1	3

Black River Section Along Roaring Brook, E. Martinsburg, N. Y.

(Number 44 on Geologic Map).

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Chaumont Formation				
Massive ledges of dark gray-black, fine and moderately fine, semi-crystalline limestone. Blocky weathering. Much black chert in upper 2 feet. *Actinoceras tenuifilum* (Hall), *Gonioceras anceps* Hall, *Lambeophyllum profundum* (Conrad), *Columnaria halli* Nicholson, *Stromatocerium rugosum* Hall	5	10	140	1
Prominent uneven parting marked by much chert.				
Massive ledge of dark gray-black, fine and moderately fine, semi-crystalline limestone. Argillaceous in places. Fucoidal markings at top. *Stromatocerium rugosum* Hall, *Lambeophyllum profundum* (Conrad)	2	9	134	3
Gradational contact.				
Dark gray, fine, uneven and thin-bedded argillaceous and granular limestone. Sublithographic at base	..	10	131	6
Prominent re-entrant.				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Lowville Formation				
Medium gray, sublithographic, weathering light gray. *Phytopsis*, gastropods	..	9	130	8
Thin, uneven beds of medium gray, fine argillaceous limestone	..	5	129	11
Dark gray, fine, massive semi-crystalline limestone. Much white calcite	..	9	129	6
Prominent parting.				
Thin beds of dark gray, moderately fine, semi-crystalline limestone, with much white calcite. *Tetradium cellulosum* (Hall), *Orthoceras multicameratum* Emmons, gastropods	..	10	128	9
Massive bed of dark gray, oolitic and semi-crystalline limestone. *Strophomena sp.*	..	7	127	11
Dark gray, moderately fine, semi-crystalline and argillaceous limestones in thin and medium beds. Full of *Tetradium cellulosum* (Hall), gastropods, pelecypods	2	8	127	4
Prominent parting.				
Dark gray, moderately fine, semi-crystalline and argillaceous limestone, with much white calcite. Medium beds above, and massive beds in lower part. *Tetradium cellulosum* (Hall), *Orthoceras multicameratum* Emmons, gastropods	2	7	124	8
Prominent parting on lumpy surface.				
Massive beds of dark gray, sublithographic, semi-crystalline, and argillaceous limestones, with conspicuous argillaceous seams. *Orthoceras multicameratum* Emmons, *Lambeophyllum sp.*, gastropods	3	3	122	1
Prominent parting.				
Medium gray, massive, sublithographic limestone. Small *Phytopsis*	..	11	118	10
Prominent parting, at 1″ shaly bed.				
Massive ledges of medium gray sublithographic limestone with argillaceous seams. Mud-cracks 20″ up, at shaly parting	5	2	117	11
Prominent parting.				
Very massive ledge of dark gray-black, fine and moderately fine, granular, semi-crystalline, and argillaceous limestone. *Tetradium cellulosum* (Hall), gastropods, brachiopods	3	4	112	9
Prominent re-entrant.				
Massive ledge of dark gray, fine, argillaceous and semi-crystalline limestone	2	..	109	5
Dark gray, fine, shaly argillaceous limestone..	1	10	107	5
Prominent parting and re-entrant.				
Massive bed of medium gray, fine, semi-crystalline and oolitic limestone, with small limestone pebbles	..	10	105	7

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Prominent re-entrant.				
Shaly beds of light gray, granular limestone, unevenly bedded	1	2	104	9
Broadly undulating upper surface of beds below.				
Massive beds of medium and dark gray, fine, semi-crystalline limestone, full of limestone pebbles. *Bathyurus extans* (Hall), and *Helicotoma sp.* in lower part	2	7	103	7
Shaly re-entrant made by beds below.				
Shaly beds of medium gray, argillaceous limestone, ripple marks and limestone pebbles at base	..	9	101	..
Medium gray, massive, sublithographic limestone	1	10	100	3
Prominent re-entrant.				
Thin beds of medium gray, fine, argillaceous limestone with peculiar lumpy weathering. Bryozoa	1	3	98	5
Dark gray sublithographic limestone	..	4	97	2
Medium gray, medium, oolitic limestone	..	9	96	10
Prominent parting.				
Light gray stylolitic sublithographic limestone. *Phytopsis*	..	10	96	1
Medium gray, fine, semi-crystalline limestone in medium beds	1	..	95	3
Shaly beds of light dull gray, earthy limestone	..	4	94	3
Medium beds of gray, fine, semi-crystalline limestone. Ripple marks near the middle	2	..	93	11
Dark gray sublithographic and semi-crystalline limestone, forming very massive beds. Stylolitic. *Tetradium cellulosum* (Hall) at top	2	2	91	11
Shale, forming prominent parting	..	2	89	9
Medium gray, stylolitic sublithographic limestone in medium and heavy beds	1	..	89	7
Thin beds of medium gray, fine, semi-crystalline and argillaceous limestone, weathering shaly. Mud-cracks near top	4	..	88	7
Prominent parting.				
Massive beds of dark gray, sublithographic limestone with limestone pebbles. *Lophospira sp.*	1	8	84	7
Prominent parting.				
Massive beds of dark gray, stylolitic sublithographic limestone, with limestone pebbles. Lower 5″ a conglomerate	1	9	82	11
Prominent parting.				
Thin beds of dark gray, fine, argillaceous limestone, with ripple marks, mud-cracks, and patches of white calcite	1	2	81	2
Dark gray, fine, semi-crystalline and sublithographic limestone, mostly in thick beds, but				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
with 3″ of shale at the middle. Many limestone pebbles in lower part	3	9	80	..
Prominent re-entrant.				
Pamelia formation				
Light, dull gray shale	..	5	76	3
Light gray, granular and semi-crystalline limestone	..	5	75	10
Light, dull gray shale	..	3	75	5
Light gray, fine, granular and semi-crystalline limestone, somewhat laminated	..	6	75	2
Prominent parting and re-entrant.				
Light gray, fine, semi-crystalline limestone with limestone pebbles. Massive bed	1	6	74	8
Prominent re-entrant.				
Light gray, saccharoidal limestone	..	8	73	2
Prominent parting.				
Light bluish gray, fine, impure shaly limestone. Conspicuous ripple marks at top. Many ostracodes	2	2	72	6
Gray-white, fine, earthy limestone, weathering very shaly and rotten	1	6	70	4
Thick beds of light and medium gray, fine semi-crystalline and sublithographic limestone. These resistant beds cap a broad bench	1	5	68	10
Light gray, fine, impure, shaly limestone	..	6	67	5
Thin and medium beds of dull light gray, fine, impure, dolomitic limestone, weathering light buff and gray. Ostracodes	2	2	66	11
Massive beds of dark gray, fine, semi-crystalline limestone, weathering bluish gray. Stylolitic	1	2	64	9
Prominent parting.				
Light dull gray, fine, dolomitic limestone, weathering light buff, and in medium beds	1	8	63	7
Massive beds of medium gray, stylolitic sublithographic limestone, weathering bluish gray..	2	2	61	11
Prominent parting and re-entrant.				
Light gray, fine, semi-crystalline limestone	..	5	59	9
Light, dull gray, fine, impure, unevenly bedded dolomitic limestone, in medium and thin beds, weathering light buff	5	4	59	4
Prominent parting.				
Massive beds of dark gray, stylolitic sublithographic limestone, weathering bluish gray..	2	1	54	..
Shaly beds of light gray earthy limestone	1	5	51	11
Thin and medium beds of light dull gray, fine, dolomitic limestone. Darker and semi-crystalline in places. Shaly weathering in places. Masses of crystalline calcite. Greenish and pinkish blotches common. *Tetradium syringoporoides* Ulrich	24	4	50	6

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Medium gray, fine, stylolitic, semi-crystalline limestone, weathering bluish gray	..	10	26	2
Thin and medium beds of light dull gray, fine, dolomitic, buff-weathering limestone	2	11	25	4
Massive and thinner beds of dark gray, fine, semi-crystalline and sublithographic limestone, weathering bluish. Many ostracodes. *Tetradium sp.* at top	4	3	22	5
Prominent parting.				
Thin beds of medium gray, fine, dolomitic limestone	..	9	18	2
Prominent parting and re-entrant.				
Massive beds of light greenish gray, red-blotched, fine sandy dolomitic limestone, weathering buff. Much white calcite in nodules	8	3	17	5
Prominent parting.				
Light greenish buff calcareous sandstone	..	11	9	2
Red and green sandy, rotten shale	1	4	8	3
Very irregular contact.				
Red and green, medium, massive calcareous sandstone, weathering light reddish buff	4	..	6	11
Red and green sandstone, weathering very rotten	..	6	2	11
Heavy-bedded reddish and grayish, medium arkose	1	..	2	5
Beds covered for 100′ horizontally. About 2′ covered.				
Thick beds of medium textured, red and green conglomerate with small and medium pebbles of Pre-Cambrian syenite	1	5	1	5
Unconformity with Pre-Cambrian.				

Black River Section at Napanee, Ontario.

(Number 7 on Geologic Map).

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Road cut for highway No. 2 just east of town. East side of Napanee river, south of road bridge.				
Chaumont Formation				
Massive bed of dark gray-black, fine, semi-crystalline limestone	1	2	68	..
Dark brownish gray, fine, argillaceous limestone, weathering shaly. Conspicuous thin clay layer about 1′ up, which may be metabentonite, *Endoceras sp.*, *Rafinesquina sp.*, *Clathrospira subconica* (Hall), bryozoa	2	8	66	10

(Table continued on page 230)

Black River Localities.

The first 48 are numbered on geologic map, Text Fig. 3.

1. Crow Bridge, Northumberland Co., Ont. Exposures along Crow River.
2. Allan Mills, Northumberland Co., Ont. North side of Crow River.
3. Marmora, Hastings Co., Ont. Road cut west of town; exposures west bank of Crow River.
4. Crookston, Hastings Co., Ont. Quarry north of the Tweed road.
5. Roblindale, Lennox & Addington Co., Ont. Road cut ½ mile south of Roblindale Sta. Lot 21, Con VIII, Richmond Tp.
6. Sharps Corners, Lennox & Addington Co., Ont. ½ mile north of Sharps Corners: small quarry. Lot 2 Conc. VII, Richmond Tp.
7. Napanee, Lennox & Addington Co., Ont. Road cut for route 2 east of town. Exposures along east sic Napanee River, south of road bridge.
8. Napanee, Lennox & Addington Co., Ont. Small quarry ¼ mile southeast of Napanee. Lot 19, Con VII, Fredericksburgh North Tp.
9. 2 miles southeast of Napanee, Lennox & Addington Co., Ont. Quarry 100 yds. south of Canadian Na R. R. tracks. Lot 19, Conc. V, Fredericksburgh North Tp.
10. 6.3 miles west of Odessa, Lennox & Addington Co., Ont. Quarry north of route 2.
11. 3.3 miles east of Odessa, Lennox & Addington Co., Ont. Quarry just east of county line, north of route
12. Collins Bay, Kingston Tp., Frontenac Co., Ont. Railroad cut at head of Bay.
13. Bur Creek (formerly Jackson's Mill), Frontenac Co., Ont. Lot 14, Conc. V, Kingston Tp. Exposur just southwest of railroad, by first underpass north of crossing.
14. Bur Creek (see above) South slope of hill north of railroad.
15. ½ mile south of Elginburg, Frontenac Co., Ont. Lot 17, Conc. V, Kingston Tp. Quarry west side Sydenham road.
16. 1.1 miles south of Elginburg, Frontenac Co., Ont. Lot 18, Conc. V, Kingston Tp. Quarry just ea of Sydenham road.
17. 1 mile east of Elginburg, Frontenac Co., Ont. Lot 21, Conc. VI, Kingston Tp., Quarry.
18. 1 mile southwest of Glenburnie, Frontenac Co., Ont. Lot 22, Conc. V, Kingston Tp. Quarry. (Ty locality for Glenburnie shale).
19. Kingston Mills, Frontenac Co., Ont. West end of C. N. R. R. cut.
20. Quarry on hill along route 15, south of Rideau Sta., Frontenac Co., Ont.
21. Quarry and road cut between Kingston and Sunbury, Frontenac Co., Ont.
22. 1.2 miles southwest of Marysville, Wolfe Island, Frontenac Co., Ont. Quarry at top of hill.
23. Just south of Marysville, Wolfe Island, Frontenac Co., Ont. Quarry on hill.
24. ½ mile northeast of Marysville, Wolfe Island, Frontenac Co., Ont. Quarry.
25. .8 mile southwest of Millens Bay, Jefferson Co., N. Y. Quarry just west route 12E.
26. Quarry about 2 miles northeast of Riverview, Jefferson Co, N. Y.
27. 4 miles west of Clayton, Jefferson Co., N. Y. Quarries in bluff of St. Lawrence.
28. ¼ mile north of Chaumont, Jefferson Co., N. Y. Quarries east of Chaumont River.
29. 1 mile southwest of Depauville, Jefferson Co., N. Y. Brook flowing into Chaumont River from northwes
30. Depauville, Jefferson Co., N. Y. Road cut just northwest of town,
31. 3.3 miles west of Limerick, Jefferson Co., N. Y. Quarry south of route 12F.
32. 2 miles east of Dexter, Jefferson Co., N. Y. Quarry and exposures along the Limerick-Brownville roa
33. Perch Lake, Pamelia Tp., Jefferson Co,. N. Y. Small stream; center east side of lake.
34. 1¼ miles east of north end of Perch Lake, Jefferson Co., N. Y. North of road crossing small creek.
35. 5.1 miles south of Pamelia Four Corners, Jefferson Co., N. Y. Quarry 100 yds. east of route 37.
36. 2 miles north of Watertown, Jefferson Co., N. Y. Quarry just northwest of railroad, northwest of route 1
37. North of Watertown, Jefferson Co., N. Y. Quarry 150 yds. east of route 37; north of intersectic routes 37 and 11.
38. Watertown town quarry (active 1937) 1.8 miles northeast of point where route 11 crosses Black Riv at Watertown, N. Y.
39. Calcium (Sanford Corners) Leray Tp., Jefferson Co., N. Y. R. R. cuts and hill south of crossroads.
40. Klock's quarry, Watertown, N. Y. South bank Black River west of dam. North side of Diamond Islan
41. Deer River, Lewis Co., N. Y. Quarries and exposures along Deer River west of route 26.
42. 1¼ miles east of Denmark, Lewis Co., N. Y. Quarry ¼ mile east of old road running between De River and Lowville.
43. Lowville, Lewis Co., N. Y. Quarry east of R. R. bridge, north of Mill Creek. Exposures along Mi Creek. Quarry in eastern Lowville, south of Mill Creek.
44. Roaring Brook, E. Martinsburg, Lewis Co., N. Y. Exposures along brook.
45. 1 mile south of Denley Sta., Lewis Co., N. Y. Quarries east of Sugar River.
46. Newport, Herkimer Co., N. Y. Quarry 1 mile north of town.
47. Middleville, Herkimer Co. N. Y. Quarry ½ mile south of town line, east of route 169.
48. Ingham Mills, Herkimer Co., N. Y. Exposures along East Canada Creek, below dam.
49. Napanee, Lennox & Addington Co., Ont. 1.4 miles northeast of town, east side Napanee Rive Exposures along stream.
50. ½ mile north of Glenburnie, Frontenac Co., Ont. Just west of Perth road.
51. 1 mile south of Pamelia Four Corners, Jefferson Co., N. Y. Brook 100 yds. east of route 37.
52. 2 miles east of Brownville, Jefferson Co., N. Y. North bank Black River, west of mill.
53. Pamelia Sta., 2 miles east of Watertown, Jefferson Co., N. Y. General Crushed Stone Co. Quarries.
54. Lowville, Lewis Co., N. Y. Quarries ½ mile north of town line, east of railroad, and due west of Dadvill
55. Newport, Herkimer Co., N. Y. Quarry in southwest part of town.
56. Montreal, Quebec, Canada. Quarry 1 mile southwest of St. Vincent de Paul, Ile Jesus, Laval Co., we of city.
57. Montreal, Quebec, Canada. Quarry ½ mile north of Pointe Claire.
58. Stewart quarry, Rockland, Russell Co., Ont.
59. Rockland, Russell Co., Ont. Small quarry by R. R. crossing between Rockland and Stewart quarry.
60. Fourth Chute of Bonnechere River, Renfrew Co., Ont.
61. Warsaw, Peterborough Co., Ont. 1 mile northeast of town, along Indian River, just north of bridg
62. Black River, Jefferson Co., N. Y. Exposures along north bank of Black River.
63. Carden, Ont.
64. Coboconk, Victoria Co., Ont.
65. Youngs Pt., Peterborough Co., Ont. Quarry along shore Clear Lake; 3 miles east of Youngs P ¼ mile east Kawartha boys camp.
66. 3 miles east of Bobcaygeon, Victoria Co., Ont.
67. 1 mile north of Foxboro, Hastings Co., Ont.
68. North of Halls Bridge, Peterborough Co., Ont.
69. 2 miles south of Burnt River, Victoria Co., Ont.
70. Chisholm, Prince Edward Co., Ont. Lot 5, Conc. IX.

THICKNESSES OF FORMATIONS AT LOCALITIES.

		Pamelia		Lowville		Chaumont		Trenton
Locality	Pre-Camb.	Ft.	In.	Ft.	In.	Ft.	In.	
1		..	..	* 2	..	21	*	
2		..	..	*13	5	3	*	
3	x	31	..	47	..	13	*	
4		..	..	* 4	..	23	7	
5		..	..	*few	..	few	*	
6		..	..	*few	..	22	..	
7		..	..	52	..	16	*	
..		..	..	*25	*	..	..	
8		..	..	* 3	..	12	*	
9		..	..	*14	3	4	6*	
10		..	..	*16	*	..	..	
11		..	..	* 9	*	..	..	
12		*10	*	..	..	..	..	
13, 14	x	50	..	35	*	..	..	
15		*10	*	..	..	..	..	
16		* 2	..	10	9*	..	..	
17		*10	6*	..	..	..	..	
18		..	..	*32	..	10	*	
19	x	17	*	..	..	..	..	
20		*23	*	..	..	..	..	
21		*35	*	..	..	..	..	
22		..	..	* 5	*	..	..	
23		..	..	*10	4	3	*	
24		..	..	* 7	5	10	8*	
25		..	..	*17	4	10	*	
26		..	..	* 3	..	5	*	
27		*50	*	..	..	..	..	
28		..	..	*24	3	17	4*	
29		*84	*	..	..	..	..	
30		*50	*	..	..	..	..	
31		..	..	*17	8	11	4*	
32		..	..	* 8	..	18	..	x
33		71	*	..	..	..	..	
34		*21	*	..	..	..	..	
35		..	..	*21	..	12	*	
36		..	..	* 4	..	6	*	
37		..	..	*23	7	6	7*	
38		..	..	*24	..	13	*	
39		*41	..	27	..	4	*	
40		..	..	..	..	20	..	x
41		..	..	*18	8	5	8*	
42		..	..	*18	10	6	6*	
43		*32	5	34	..	13	..	x
44	x	76	3	54	6	9	5*	
45		..	..	* 7	..	9	*	
46		..	..	*31	..	..	..	x
47		..	..	*16	..	..	..	x
48		..	..	*27	..	..	..	x
49		..	..	*52	..	15	*	
50		*17	*	..	..	..	..	
51		*10	6*	..	..	..	..	
52		..	..	* 7	..	16	*	
53		..	..	* 1	..	24	*	
55		..	..	*18	..	..	..	x

Key: x indicates formation present.
* indicates formation incomplete below (*15), or above (15*).

(Table continued from page 227)

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Massive ledges of dark-gray-black, fine, semi-crystalline limestone with some argillaceous partings. Forms single ledge at times. Fucoidal markings on top. *Columnaria halli* Nicholson, *Lambeophyllum profundum* (Conrad), *Actinoceras tenuifilum* (Hall) *Stromatocerium*	7	..	64	2
Prominent plane parting.				
Dark gray, fine, semi-crystalline and sublithographic limestone with argillaceous partings. Medium, uneven beds. Weathers light gray	2	9	57	2
Uneven parting.				
Thin beds of dark gray, fine semi-crystalline limestone, weathering gray-white	2	3	54	5
Prominent uneven parting.				
Lowville Formation				
Massive beds of dark brownish gray, fine semi-crystalline, sublithographic, and argillaceous limestones, weathering white. *Tetradium fibratum* Safford, *Tetradium cellulosum* (Hall)	2	9	52	2
Prominent parting.				
Medium and thin beds of black, sublithographic and argillaceous limestone, weathering white and dark bands. *Tetradium cellulosum* (Hall), *Isotelus sp.*, *Leperditia sp.*, bryozoa....	5	1	49	5
Thick beds of black, fine, semi-crystalline, with some argillaceous limestone.	1	4	44	4
Medium beds of dark argillaceous limestone..	1	2	43	2
Thin shaly beds of dark sublithographic and argillaceous limestones	1	5	42	..
Prominent parting.				
Thick and medium beds of dark brownish gray-black, fine, semi-crystalline and sublithographic limestone	1	7	40	7
Dark brownish gray, moderately fine semi-crystalline and oolitic limestone, full of pelecypods (*Cyrtodonta sp.*)	..	5	39	..
Thick beds of dark gray, moderately fine, semi-crystalline limestone, with many pelecypods (*Cyrtodonta sp.*)	3	1	38	7
Prominent shaly parting.				
Thin beds of dark gray-black, fine semi-crystalline limestone with shaly partings. *Bathyurus extans* (Hall), *Tetradium cellulosum* (Hall), *Cyrtodonta huronensis* Billings	3	11	35	6
Medium, uneven beds, thicker below, of black, fine, semi-crystalline limestone, with oolitic bands and a few limestone pebbles. *Tetradium cellulosum* (Hall)	3	1	31	7
Prominent parting.				
Very massive ledge above, thinner below, of				

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
medium gray, medium to fairly coarse semi-crystalline limestone. *Tetradium fibratum* Safford	3	6	28	6
Medium beds of dark gray, medium, semi-crystalline limestone	..	5	25	..
Dark gray-black, fine, semi-crystalline limestone with argillaceous seams. *Tetradium cellulosum* (Hall)	..	7	24	7
Thick beds of dark gray-black, fine, semi-crystalline limestone. *Tetradium cellulosum* (Hall), *Orthoceras multicameratum* Emmons	1	6	24	..
Thick beds of dark gray-black, fine, semi-crystalline limestone. Crystal molds in upper 7″. Pebbles of sublithographic limestone in lower part	1	9	22	6
Thin beds of dark gray-black, fine, semi-crystalline and sublithographic limestones, with shaly partings. Weathering grayish-white	4	7	20	9
Very prominent parting.				
Dark gray, moderately fine, massive oolitic limestone. Upper 16″ full of limestone pebbles, and some at bottom	2	6	16	2
Prominent parting.				
Dark gray, fine, massive, sublithographic and saccharoidal limestone	1	9	13	8
Variable thickness of black shale	..	5	11	11
Black fine massive flinty limestone	..	5	11	6
Dark gray, massive, saccharoidal and granular limestone. *Tetradium sp.*	1	..	11	1
Dark gray, fine, shaly limestone, with limestone pebbles in middle	1	..	10	1
Dark gray, fine and moderately fine, semi-crystalline limestone. Limestone pebbles and crystal molds in upper half	1	7	9	1
Dark gray, fine, argillaceous and shaly limestone	..	7	7	6
Black, finely saccharoidal, massive limestone, with limestone pebbles in upper part	1	4	6	11
Prominent shaly parting.				
Dark gray-black, sublithographic and argillaceous limestones, with *Tetradium cellulosum* (Hall) in upper part	2	..	5	7
Prominent parting.				
Massive ledge of dark gray, saccharoidal limestone, oolitic and with limestone pebbles in lower part	1	7	3	7
Prominent parting.				
Medium gray, fine and medium, thin-bedded granular limestone, full of limestone pebbles. Gastropods, bryozoa	2	..	2	..

	Individual		Cumulative	
	Ft.	In.	Ft.	In.
Covered: Unless there is faulting here, there are about 42′ of beds covered between the road-cut section and the river section.				
River section:				
Medium gray, fine, massive, flinty sublithographic limestone	2	..	25	3
Prominent parting.				
Dark gray, fine, thin-bedded, saccharoidal and sublithographic limestone. *Strophomena sp.*, cephalopods, bryozoa	6	..	23	3
Massive ledge of dark gray sublithographic and fine semi-crystalline limestone	1	10	17	3
Dark, thin and unevenly bedded argillaceous limestone	..	7	15	5
Prominent parting.				
Dark gray, fine, thin-bedded argillaceous limestone, weathering shaly	1	..	14	10
Prominent parting.				
Medium beds of dark gray, fine and moderately fine, massive oolitic and semi-crystalline limestone. *Raphistomina sp.*, pelecypods, cephalopods, trilobites, *Leperditia sp.*	1	8	13	10
Dark gray, fine, thin-bedded argillaceous limestone. *Tetradium cellulosum* (Hall)	..	3	12	2
Dark gray, fine, massive, granular and saccharoidal limestone. *Cyrtodonta huronensis* Billings, *Bathyurus extans* (Hall), *Isotelus sp.*, *Pterygometopus sp.*, *Raphistomina sp.*	1	6	11	11
Dark gray, rather thin-bedded, sublithographic limestone. *Tetradium cellulosum* or *syringoporoides* near top	1	2	10	5
Prominent parting.				
Dark, medium, massive oolitic limestone	1	3	9	3
Prominent parting.				
Dark gray, fine and medium, massive sublithographic, semi-crystalline, and saccharoidal limestone, with undulating partings. *Tetradium fibratum* Safford, or *T. cellulosum* (Hall). Bryozoa common	2	1	8	..
Prominent undulating parting.				
Dark gray, moderately fine to medium, massive semi-crystalline limestone, with limestone pebbles and petroliferous odor. *Lophospira sp.*	1	6	6	11
Prominent parting.				
Dark gray, fine, massive semi-crystalline and sublithographic limestone	1	5	4	5
Prominent undulating parting.				
Dark gray, fine and moderately fine semi-crystalline and sublithographic limestone. Upper 8″ weathering shaly	3	..	3	..

STRATIGRAPHIC DISTRIBUTION OF BLACK RIVER FAUNAS.

	Pamelia		Lowville		Chaumont		Collecting Localities
	L	U	L	U	L	U	
Stromatoporoidea							
Cryptophragmus antiquatus Raymond	o	..	o	..	..	..	33, 63
Stromatocerium rugosum Hall	..	..	..	..	*	*	2, 4, 37, 43, 64, 70
Stromatoporoids ind.	..	..	o	x	..	..	16, 18, 28, 31
Anthozoa							
Columnaria halli Nicholson	..	..	..	..	*	x	1, 3, 4, 8, 18, 41, 43, 46, 57, 61, 65, 67
Lambeophyllum profundum (Conrad)	..	..	..	o	x	x	1, 8, 37, 41, 43, 44, 48
Lichenaria coboconkensis Okulitch	..	..	..	o	o	o	10, 18, 65, 66
Lichenaria minor Ulrich	..	..	..	..	..	o	40
Tetradium cellulosum (Hall)	..	..	x	*	o	..	1, 5, 7, 9, 10, 14, 18, 23, 31, 37, 41, 42, 43, 44, 48, 58, 64
Tetradium clarki Okulitch	..	..	..	o	..	..	2
Tetradium fibratum Safford	..	..	..	o	x	x	1, 6, 7, 18, 36
Tetradium halysitoides Raymond	..	..	..	o	..	..	11
Tetradium syringoporoides Ulrich	x	x	..	..	..	..	34, 43
Bryozoa							
Batostoma winchelli (Ulrich)	..	..	..	*	*	..	1, 4, 7, 8, 9, 65
Eridotrypa sp.	..	..	..	o	..	..	28
Pachydictya foliata Ulrich	..	..	..	..	x	..	1, 4
Phyllodictya frondosa Ulrich	..	..	..	x	..	..	
Rhinidictya mutabilis (Ulrich)	..	..	x	x	x	..	18, 28, 39
Rhinidictya sp.	..	o	x	x	x	..	1, 31, 43, 65
Brachiopoda							
Camerella volborthi Billings	..	..	..	..	o	..	18
Doleroides gibbosus (Billings)	..	..	..	..	..	o	1, 4
Doleroides pervetus (Conrad)	..	..	..	..	..	o	1
Glyptorthis bellarugosa (Conrad)	..	..	..	..	..	o	4
Glyptorthis insculpta (Hall)	..	..	..	..	..	o	5
Hesperorthis tricenaria (Conrad)	..	..	..	..	x	x	41, 62
Hesperorthis sp.	..	..	..	..	o	o	37, 38, 43

Key: * Abundant x Common o Rare

	Pamelia		Lowville		Chaumont		
	L	U	L	U	L	U	Collecting Localities
Leptaena radialis Okulitch					o		40, 43
Pionodema sp.					o	o	1, 38, 61
Protorhyncha sp.		o					43
Rafinesquina clara Okulitch					x		43, 57
Rafinesquina minnesotensis (N. H. Winchell)				x	x		4, 9, 32
Rafinesquina sp.				x	*		10, 11
Rhynchotrema sp. cf. minnesotense Fenton					x	*	32, 40
Rhynchotrema sp. cf. increbescens (Hall)				o	x	x	1, 3, 11, 35, 37, 38, 43
Strophomena sp. cf. delicatula Fenton					x	x	61
Strophomena sp.			o	x	x	x	1, 3, 9, 10, 44
"Valcourea deflecta (Conrad)"					o		24
Zygospira recurvirostra (Hall)		x	x	x	o		1, 3, 8, 9, 12, 25, 43
Pelecypoda							
Ctenodonta sp.				o		o	9, 23, 32
Cyrtodonta huronensis Billings		o	*	x			5, 7, 13, 18, 43, 63, 69
Cyrtodonta sp.				o			10
Vanuxemia sp.					o		4, 40
Gastropoda							
Bucania sp.						o	1
Clathrospira subconica (Hall)					o		1, 6, 8
Helicotoma sp. cf. missouriensis Branson			o				63
Helicotoma sp.			x	x			10, 11, 18, 41, 43, 44
Holopea similis Ulrich & Scofield				o			9
Hormotoma gracilis (Hall)				x		x	1, 4, 9, 32, 43, 66
Hormotoma wilsoni Okulitch					o		68
Liospira sp.						o	1
Lophospira bicincta (Hall)			x	x			11, 25, 32, 35, 39
Lophospira oweni Ulrich & Scofield			o		o		65, 70
Lophospira perangulata (Hall)	o		*	*	x		9, 10, 11, 16, 18, 23, 34, 41, 62
Lophospira sp.			o		o		7, 40, 44
Maclurites sp.						o	40
Raphistoma stamineum (Hall)						o	61
Raphistomina modesta Ulrich				x			16

Key: * Abundant x Common o Rare

	Pamelia L	Pamelia U	Lowville L	Lowville U	Chaumont L	Chaumont U	Collecting Localities
Raphistomina sp.	o	..	x	x	x	..	6, 7, 18, 32, 34, 69
Subulites regularis Ulrich & Scofield	..	..	..	o	..	..	9, 10
Subulites sp.	..	..	..	..	o	..	61
Trochonema umbilicatum Hall	..	..	x	x	o	..	9, 18, 41, 43, 62
Trochonema sp.	..	..	..	o	o	..	18, 41
Cephalopoda							
Actinoceras ruedemanni Foerste & Teichert	..	..	..	..	..	o	32, 40
Actinoceras tenuifilum (Hall)	..	..	..	..	*	*	3, 4, 6, 8, 11, 32, 35, 40, 41, 44, 52
Centrocyrtoceras bondi (Safford)	..	..	..	o	..	..	43
Cycloceras decrescens (Billings)	..	..	o	o	o	..	4, 9, 43, 63
Cycloceras romingeri Foerste	..	..	..	o	o	..	9, 43
Deiroceras sp. cf. kindlei Foerste	..	..	..	..	o	o	1, 2
Endoceras subcentrale Hall	..	..	..	..	x	x	4, 40
Gonioceras anceps Hall	..	..	..	..	x	*	1, 4, 6, 8, 32, 35, 37, 40, 41, 44
Gonioceras sp. cf. anceps Hall	..	o	..	..	..	..	13
Nanno kingstonensis Whiteaves	o	..	..	..	..	..	19
Orthoceras multicameratum Emmons	..	..	*	*	o	..	2, 14, 18, 22, 32, 35, 41, 42, 43
Orthoceras sp.	o	..	..	..	..	..	33
Plectoceras undatum (Conrad)	..	..	..	..	x	*	32, 37, 41
Zitteloceras hallianum (D'Orbigny)	..	..	..	o	..	..	9
Trilobita							
Bathyurus extans (Hall)	..	o	*	*	..	..	7, 9, 16, 38, 39, 43, 44, 63, 69
Bathyurus sp. cf. johnstoni Raymond	..	..	..	o	..	..	10
Bathyurus sp. cf. johnstoni, cf. spiniger	..	..	..	o	..	..	9, 14
Bathyurus spiniger (Hall)	..	..	..	o	o	..	10, 65
Bumastus milleri (Billings)	..	..	x	x	x	..	9, 10, 18, 65
Ceraurinus scofieldi (Clarke)	..	..	..	..	..	o	32
Hemiarges sp.	..	..	..	o	..	..	10
Illaenus latiaxiatus Raymond & Narraway	..	..	..	..	o	..	4
Illaenus sp.	..	..	..	o	o	..	4, 43
Isotelus sp. cf. gigas deKay	..	..	..	o	..	..	9

Key: * Abundant x Common o Rare

	Pamelia		Lowville		Chaumont		Collecting Localities
	L	U	L	U	L	U	
Isotelus sp.			x				43, 63
Isotelus sp.					o	o	1
Onchometopus sp.			o				43
Pterygometopus schmidti Clarke				o			10
Pterygometopus sp.				o	o	o	1, 9
Ostracoda							
Aparchites sp.			x	x			31, 43
Aparchites or Schmidtella	x						34
Isochilina armata Walcott			x				43
Isochilina sp.				x			36
Leperditia fabulites (Conrad)				x	x		3, 43, 61
Leperditella sp.	x						34
Schmidtella sp.				x			31
Annelida ?							
Phytopsis tubulosum Hall			o	x			48
Phytopsis (small)			x	o			1, 41, 48

Key: * Abundant x Common o Rare

Black River Faunas.

Pamelia Formation. The Pamelia contains a small fauna. Most of the typically marine forms are found in the dark, semi-crystalline and sublithographic limestones of the lower division. The one distinctive form is *Tetradium syringoporoides* Ulrich, which occurs in both divisions, and has also been reported from the Stones River of the central Appalachians. *Cryptophragmus antiquatus* Raymond was described by Raymond from the upper Pamelia of Ontario and New York, but has been found by the writer in New York only in the upper part of the lower Pamelia. In Ontario it apparently also occurs in the lower Lowville. *Nanno kingstonensis* Whiteaves, which is so abundant in the formation at Kingston Mills, Ontario, has not been seen elsewhere. An unidentifiable form of *Orthoceras* has been found in the type lower Pamelia at Perch Lake, N. Y. An interesting occurrence is that at Bur Creek, Ontario, of a form of *Gonioceras* which can not be distinguished from *Gonioceras anceps* Hall of the Chaumont. The long-ranging *Lophospira perangulata* (Hall), a *Bathyurus* indistinguishable from *Bathyurus extans* (Hall) of the Lowville, and *Cyrtodonta huronensis* Billings are

rarely found. Numerous ostracodes occur at various horizons throughout the formation. Of these, forms of *Aparchites* and *Leperditella* are common.

Lowville Formation. Characteristic fossils are *Tetradium cellulosum* (Hall), *Bathyurus extans* (Hall), and *Orthoceras multicameratum* Emmons.

Stromatoporoids occur at various horizons in the Lowville. They lie with their bases flat, parallel to the bedding, and have convex upper surfaces. Small specimens are conspicuous at Chaumont, New York, and Glenburnie, Ontario. Heads up to two feet in diameter are seen near Limerick, New York, and some up to three feet in diameter and one foot high occur near Elginburg, Ontario. These fossils are often sufficiently abundant to form continuous reef-like structures.

Tetradium cellulosum (Hall) is a guide fossil for the Lowville, and more abundant in the upper division of the formation, in New York and eastern Ontario sections. In western Ontario, it appears occasionally in the lower Chaumont. *Tetradium fibratum* Safford appears sparingly in the upper Lowville at Napanee, Ontario, and in the Watertown, New York, area. Okulitch[73] reports it from the Montreal area. *Tetradium halysitoides* Raymond and *Tetradium clarki* Okulitch are rare and have been found only in Ontario. *Lichenaria coboconkensis* Okulitch appears only near Odessa, Ontario.

Among Bryozoa, several species are abundant or common but none is confined to this formation. *Batostoma winchelli* (Ulrich) appears most commonly, along with *Rhinidictya mutabilis* (Ulrich) and *Phyllodictya frondosa* Ulrich.

The Strophomenacea are the commonest of brachiopods in Black River formations. *Strophomena* is more abundant than *Rafinesquina*. *Rafinesquina minnesotensis* (N. H. Winchell) is common in New York and Ontario, ranging upward into lower Chaumont. Forms of *Strophomena*, probably representing an undescribed species, have not been distinguished from those of the Chaumont. The long-ranging *Zygospira recurvirostra* (Hall) is more common in the Lowville than in other Black River beds.

The only abundant species of pelecypod appears to be

[73] Okulitch, V. J.: 1936, The Black River group in the vicinity of Montreal. Geol. Survey Canada, Mem. 202, Pt. 4, p. 120.

Okulitch, V. J.: 1939, The Black River group in the region between Montreal and Quebec. Amer. Jour. Sci., Vol. 237, p. 84.

Cyrtodonta huronensis Billings, which often fills some of the argillaceous limestone beds of the Lowville.

Since gastropods tend to be facies fossils, most species range through the Lowville and Chaumont. However, *Lophospira bicincta* (Hall) seems to be confined to the Lowville, and *Lophospira perangulata* (Hall) is more abundant here than in the Pamelia or Chaumont. *Trochonema umbilicatum* Hall, *Raphistomina modesta* Ulrich, and *Hormotoma gracilis* (Hall) occur in the same way. *Subulites regularis* Ulrich and Scofield appears only in Ontario.

The cephalopods are one of the few groups which have distinctive representatives in Black River formations. *Orthoceras multicameratum* Emmons is a good guide fossil for the Lowville, since it is very abundant throughout the formation in Ontario and New York, and, except for one or two possible occurrences in the lower Chaumont of Ontario, confined to that formation. Genera not previously reported from the Black River of the region studied are *Cycloceras*, *Centrocyrtoceras*, and *Zitteloceras*. *Cycloceras decrescens* (Billings) is rather characteristic of the Lowville, but ranges higher. Rarer are *Centrocyrtoceras bondi* (Safford) and *Zitteloceras hallianum* (D'Orbigny).

Most of the Black River trilobites are long-ranging forms. *Bathyurus extans* (Hall) is probably the only trilobite which may be called a good guide fossil. This species is exceedingly abundant throughout the Lowville, not only in southeastern Ontario and New York, but also in the vicinity of Montreal. *Bathyurus johnstoni* Raymond and *Bathyurus spiniger* (Hall) occur in Ontario. The latter species and a form of *Hemiarges* which appears in the Lowville are of special interest because they have been considered by most authors to be characteristic of Trenton beds.

Chaumont Formation. The Chaumont is rather easily distinguished faunally in the field by the presence of such large cephalopods as *Actinoceras tenuifilum* (Hall), *Gonioceras anceps* Hall, *Plectoceras undatum* (Conrad), and *Endoceras subcentrale* Hall. Other distinctive species are the Stromatoporoid *Stromatocerium rugosum* Hall, the corals *Columnaria halli* Nicholson and *Lambeophyllum profundum* (Conrad), and species of the brachiopod genera *Hesperorthis* and *Rhynchotrema*. Smaller members of the fauna have gone more or less unrecognized.

Tetradium fibratum Safford is the only abundant and characteristic species of *Tetradium* in the Chaumont. As previously mentioned, it appears first in the upper Lowville. *Columnaria halli* Nicholson forms large heads, and is especially abundant in the lower Chaumont. However, Cushing[74] reports it from the upper Lowville of the Watertown area, and Kay[75] from the Rockland of Ontario.

Lambeophyllum profundum (Conrad) is very abundant and characteristic of the formation in New York and Ontario. Prenuntial forms appear in the Lowville at Lowville, New York and Ingham Mills, New York. *Lichenaria minor* Ulrich has been found only in New York.

Five genera of brachiopods, four of them orthids, are confined to the Chaumont, as far as the Black River is concerned. They presage the abundance of such forms in the Trenton, and are *Hesperorthis*, *Glyptorthis*, *Doleroides*, *Pionodema*, and *Leptaena*. *Hesperorthis tricenaria* (Conrad) is widely distributed and abundant in New York. *Glyptorthis bellarugosa* (Conrad), *Glyptorthis insculpta* (Hall), *Doleroides gibbosus* (Billings), and *Doleroides pervetus* (Conrad) are apparently limited to the Chaumont of Ontario. This distribution may be controlled by lithofacies, since these species occur in thin-bedded argillaceous limestone not found in the formation in New York. *Rafinesquina clara* Okulitch is apparently confined to the Chaumont, and specimens from Lowville, New York, correspond exactly to the type material described by Okulitch from the "Leray" of Montreal. Many *Strophomenae* appear to be like those of the Lowville, but *Strophomena delicatula* Fenton is a distinctive and abundant form in Ontario. *Rhynchotrema* is represented most commonly by *Rhynchotrema minnesotensis* Fenton and *Rhynchotrema increbescens* (Hall).

The only distinctive gastropod seems to be *Clathrospira subconica* (Hall), a form collected only in Ontario.

The Chaumont has been known for its large cephalopods, which represent few species, but which are very numerous. The most abundant is *Actinoceras tenuifilum* (Hall), and a form indistinguishable from it has been found to occur very rarely in the upper Lowville. It is thus reported by Cushing[76] in the

[74] Cushing, H. P., Ruedemann, R., and others: op. cit., p. 84.
[75] Kay, G. M.: op. cit., p. 252.
[76] Cushing, H. P., Ruedemann, R., and others: op. cit., p. 84.

Watertown area, and has been seen about ten feet below the top of the Lowville at Ingham Mills, New York. Species of *Endoceras*, of which *E. subcentrale* Hall has been most commonly observed, are abundant and conspicuous for their large size. The distinctive *Gonioceras anceps* Hall was stated by Cushing in 1910 to have not been found elsewhere than in the neighborhood of Watertown, New York. However, it has been found in most exposures of the Chaumont from Roaring Brook, East Martinsburg, New York, to Crow Bridge, Ontario, and at intervening localities such as Napanee and Crookston, Ontario. *Plectoceras undatum* (Conrad), although abundant locally in New York sections, has not been seen in Ontario.

Chaumont trilobites are not distinctive, but *Illaenus latiaxiatus* Raymond and Narraway and *Ceraurinus scofieldi* (Clarke) appear to be limited to the formation.

Dept. of Geology,
Columbia University,
New York City.