Art. XVIII.—*Nomenclature of the Lower Paleozoic Rocks of New York;* by H. P. Cushing.*

Introduction.—Work on the early Paleozoic rocks of northern New York during the past few years has not only added materially to our knowledge concerning them, but has emphasized the necessity of certain modifications and certain amplifications of the nomenclature. Since these results are scattered through various official publications, it is believed that a summary of them will be a convenience to many.

Though begun by Cushing, the work has been actively participated in by Drs. Ulrich and Ruedemann. We have been so closely associated, and have so freely shared ideas, both in the field and in correspondence, that it is now an utter impossibility to assign to each his appropriate share. The writer therefore appears here merely as the scribe, and not at all as the sole author.

The Saratogan Formations.

Ulrich and Cushing have, in a recent paper, presented the detailed evidence which has led to the belief that the Little Falls dolomite, formerly classed with the Beekmantown, belongs rather in the same group with the Potsdam sandstone. It is not the intention to repeat the discussion here, but merely, for the sake of completeness, to note the matter.† The Saratogan in New York consists of the Potsdam sandstone below and Little Falls dolomite above, with a series of passage beds between named the Theresa formation. The Little Falls dolomite is shown to be the equivalent of the basal division and a half of what was formerly classed as Beekmantown in the Champlain valley. It comprises division A and the lower half of division B. In the Mohawk valley the Potsdam disappears because of overlap and the Little Falls rests on the Precambrian. In the Black river valley both disappear and still younger beds lie on the Precambrian.

The fossiliferous limestone which overlies the Potsdam at Saratoga and which furnished the fauna described by Walcott and determined by him to be upper Cambrian, was named the Greenfield limestone by Clarke and Schuchert.‡ This name was preoccupied, having been applied by Grabau to an Ohio formation of Monroe age. We propose to call it the Hoyt limestone, and we regard it as a local, calcareous phase of the basal portion of the Little Falls dolomite, of which it becomes a member. It is exceedingly local, being confined, so far as

* Published by permission of the State Geologist of New York.

† Bull. 140, N. Y. S. M., pp. 97–140. ‡ Science, Dec. 15, 1899.

surface exposures are concerned, to the immediate vicinity of Saratoga.

The Potsdam and Little Falls are the only two absolutely conformable formations in the entire early Paleozoic section of New York. In all other cases there is an unconformity between formations and frequently between subformations. To draw the line between Cambrian and Ordovician at this horizon is thus to draw it at the one place where there was continuous deposition between two formations. Structurally and faunally the Potsdam and the Little Falls belong to the same system and group. Their normal affiliations are with one another. And there is no diastrophic warrant whatever for putting a systemic boundary between them.

The Beekmantown Group.

In this paper just cited, Ulrich and Cushing separated from the Little Falls dolomite the upper division, heretofore classed with it, which Vanuxem called the "fucoidal beds," and which careful reading of his report shows that he would himself have separated as a distinct formation, had his district alone been in question. The name proposed for this new division is the Tribes Hill limestone. It is much more calcareous and more fossiliferous than the Little Falls, and there is a distinct and widespread break between the two. Ulrich regards the fauna as of earliest Beekmantown age, and on the basis of his determination the line between the Beekmantown and Saratogan is drawn at this break. This formation is the only representative of the Beekmantown which occurs on the south and west sides of the Adirondack shield.

In the Champlain valley Brainard and Seely some years ago divided the Beekmantown into five subdivisions, which they lettered from A to E.* The equivalence of division A and the lower half of B with the Little Falls dolomite, and the impropriety of classing them as Beekmantown at all, having now been shown, there yet remain the upper three and one-half divisions, with a thickness of from 1300 to 1400 feet. The thorough faunal study of this formation, and its proper subdivision and naming, constitute the most important problem which awaits the investigator of the early Paleozoic rocks of New York. It is reasonably certain that the four lithologic divisions of Brainard and Seely will require much readjustment, when the faunas are collected and studied, and it would be folly therefore to give them names as at present constituted.

It is not known whether the Tribes Hill limestone is present in the Champlain valley or not. If it be, it is represented

* Bull. Am. Mus. Nat. Hist., vol. iii, pp. 1–23.

in the dove limestones of division B; but up to the present these have furnished no fossils and precise correlation cannot be made until these are forthcoming. We greatly doubt its presence; we doubt if the Beekmantown of the Champlain valley has a single member in common with that of the Mohawk. And certainly, with the exception of the Tribes Hill, Beekmantown deposition in New York was confined to the Champlain trough and to its prolongation southward; and to a branch trough extending up the St. Lawrence valley. The Mohawk and Black river valleys were unsubmerged. And, during Tribes Hill time on the other hand the Mohawk and lower Black river valleys were submerged, the Champlain valley probably not. This contrasted distribution might seem to support the recent suggestion of Raymond that the Tribes Hill should be classed with the Little Falls dolomite beneath rather than with the Beekmantown.* Raymond's argument is wholly paleontologic, and must be answered by a paleontologist. There was oscillation both preceding and succeeding the Tribes Hill, and the relative importance of the two breaks cannot be determined in New York. To be able to class the Tribes Hill with the Little Falls would much simplify areal mapping in the Watertown region, where the Saratogan has comparatively meager representation. The thinned western edge of the Potsdam is present, followed by some 25 feet of passage beds (Theresa). These are directly overlaid by a similar small thickness of impure limestones with the Tribes Hill fauna. The Tribes Hill beds are so like the calcareous members of the passage beds beneath that Cushing was constrained to map the two together as a single lithologic unit. And yet, according to our results, the boundary between two systems must lie midway in that thin, lithologic unit. But Ulrich is positive in his correlation of the faunas and, in reply to the incongruity of distribution between the Tribes Hill and the remainder of the Beekmantown, points out that the early Devonian was characterized by similar incongruity, the distribution of the Helderberg and Oriskany rocks contrasting sharply with that of the Onondaga and its successors.

The Chazy Group.

There is an unconformity between the Beekmantown and Chazy groups which marks a time of extensive withdrawal of the sea from the New York region. Like their Beekmantown predecessors the Chazy rocks in New York are chiefly restricted to the Champlain trough. They do not however run southward along that trough as the Beekmantown rocks do, but

* This Journal, Nov., 1910.

pinch out before the upper end of Lake Champlain is reached; and are wholly absent at Ticonderoga and all points south of that within the State.

In the Champlain valley the group is separable into three well-marked formations, as Brainard and Seely were the first to show.* These were named by Cushing the Day Point, Crown Point and Valcour limestones.† More recently a formation of supposed Chazy age has been recognized and described in the Watertown region and named by Cushing the Pamelia limestone.‡ It has a length of outcrop of some 70 miles in the State of New York, and probably an even greater extent across the border in Canada. In this district it rests either on Tribes Hill, Theresa or Potsdam, or else on the Precambrian, and is overlain unconformably by the Lowville. It cannot be successfully correlated with any of the Champlain Chazy, either lithologically or faunally, and seems to represent a deposit in a wholly separate basin; and therefore evidence as to its precise position must be obtained from without the State.

In 1896 Winchell and Ulrich revived Safford's name *Stones River* group for the deposits of the interior basin, or basins, representing the Chazy interval; or more strictly speaking, the lower and middle Chazy interval (Day Point and Crown Point) of the Champlain section.§ The Chazy and the Stones River basins of deposit were for the most part separate, with but slight and interrupted opportunity for commingling of faunas. The Pamelia limestone is the New York representative of the Stones River group, but represents only its extreme upper portion.

The southern Pennsylvania section which has recently been described by Stose seems to furnish the evidence desired for closer correlation of the Pamelia.‖ Ulrich studied the faunas and furnished the correlation statements for that folio, and the correlation with the New York formations, as here given, is due to him. The Beekmantown of the Chambersburg region is overlaid by the Stones River formation, with a maximum thickness of 1050′; and this by the Chambersburg limestone, of 750′ maximum thickness. Ulrich regards the Pamelia as the equivalent of the upper part of the upper division of the Stones River of the Chambersburg section. The middle division, which carries *Maclurea magna* and other fossils is regarded as the equivalent of the New York middle Chazy (Crown Point limestone).

* Am. Geol., vol. ii, pp. 323–330.
† Bull. 95, N. Y. S. M., p. 368.
‡ Bull. G. S. A., vol. xix, p. 161; Bull. 145, N. Y. S. M., pp. 68–79.
§ Geol. Surv. Minn., vol. iii, p. xc.
‖ Mercersburg-Chambersburg Quadrangles, Folio 170, U. S. G. S.

On the Mercersburg quadrangle the basal 150–170′ of the Chambersburg limestone carries a fauna which, on the basis of several identical species, among them *Rhynchonella plena*, Ulrich correlates with the upper Chazy (Valcour limestone) of the New York section. This directly overlies the upper Stones River (Pamelia), and just above it the Lowville fauna comes in. Hence it follows that the New York Pamelia is, in age, intermediate between the middle and the upper Chazy of the Champlain Valley, and that there must be a break there between those divisions. Also that the New York Chazy consists of four divisions, Day Point, Crown Point, Pamelia and Valcour limestones. And further, that Chazy deposition was confined to the Champlain trough until Pamelia time; that then the northwest border was overlapped by the sea which withdrew, at the same time, from the Champlain trough; and that, at the close of the Pamelia, the reverse oscillation took place, the sea returning to the Champlain trough and withdrawing on the northwest.

Lowville and Black River Limestones.

In their readjustment of the nomenclature of the New York formations in 1899, Clarke and Schuchert gave the name Lowville limestone to the formation previously called the Birdseye.* Also, following the custom which had gradually grown up in the State, they classed the darker-colored limestones between the Lowville and the Trenton as Black River limestone. This usage of Black River did not at all accord with that of the early New York geologists, but was convenient and had gradually become customary. However, the type sections of neither had received detailed study, and hence they had not been precisely defined.

In their areal mapping in the Watertown region in 1907–08 Cushing and Ruedemann found the typical, thin-bedded, dove limestones of the Lowville to be overlaid by a thickness of 25–30′ of thick-bedded, black, blocky limestone, above which followed the Trenton. An uncomformity was also detected between the black beds and the dove limestones. The black limestones constituted a natural, lithologic unit, and we so mapped them and called them Black River, this being the type region of the formation. Subsequent study of the section in company with Ulrich disclosed another break midway in the black limestones, separating them into a lower portion with much chert, and an upper in which chert was chiefly lacking, and whose chief member is the massive, chertless bed known as the *7 foot tier*. That this upper break was a more con-

* Science, Dec. 15, 1899.

siderable one than that between the black and dove limestones was suggested by the limited distribution of the 7 foot tier as compared with that of the chert beds beneath, the latter accompanying the Lowville all the way up the Black River valley and also across into Ontario, while the 7 foot tier was restricted to the immediate vicinity of Watertown. Ulrich also urged that, in many localities without the State where he had studied the sections, the lower break was bridged by deposit, so that the dove limestone Lowville graded upward into the cherty beds; and that the sharp lithologic difference between the two in the Watertown region was local, rather than the general rule. He conceded that at Watertown the natural method for areal mapping purposes was to class the two black limestones, the chert beds and the 7 foot tier, together as we had done. But he emphasized the fact that this was not the usual rule, that in many districts no separation of the chert beds from the Lowville was possible, and that the name Lowville limestone was capable of vastly more extensive application as a formational name were the chert beds included in the formation at the type locality.

Ruedemann, Ulrich and Cushing had also, during 1907, 1908 and 1909, carefully studied the beds, latterly called Black River, in many localities on all sides of the Adirondack region. These beds are mostly thin, and often of patchy distribution, especially in the Mohawk valley, and we found that they were of quite various age, representing the thin, shoreward edges of embayment deposits, with repeated and quite local oscillations of level. Plainly a considerable time interval was represented, and the term *Black River* was one of very loose application.

In the final reports of the four geologists of the early survey (1842) the name Black River limestone was somewhat variously used by the different men, though the statements of Vanuxem, Mather and Hall in regard to it do not greatly vary. They make it include the interval between the Calciferous and the Trenton. Vanuxem heads his chapter on the group as follows:

"Black River limestone. Synonyms—Birdseye limestone, Mohawk limestone, base of the Trenton limestone, as used in the reports of the Third District. Black marble of Isle la Motte, Seven-foot-tier, and Chazy limestone of Dr. Emmons, *the latter mass connecting the Birdseye with the Calciferous sandrock proper.*"*

The formation was chiefly confined to the Second and Third Districts, and Mather and Hall, in their reports, apparently simply followed Vanuxem.

* Geol. 3d Dist., p. 38.

Emmons did not use the term Black River at all, though the Chazy was practically confined to his district, and the remainder of the formation was as fully shown as in the Third district. It is, however, quite differently shown. He plainly did not sympathize with the term, and probably objected to the inclusion of Chazy in it. The above quotation also indicates that Vanuxem did not feel sure of the propriety of extending the term to cover the Chazy. Emmons used instead the terms Chazy limestone, Birdseye limestone, and Isle la Motte marble, and did not sanction the use of a group term to include the three. Emmons correlates the 7 foot tier at Watertown with the black limestone at Glens Falls, Chazy, and Isle la Motte. But the Glens Falls, Chazy and Isle la Motte occurrences represent the horizon of the chert beds rather than that of the 7 foot tier.

Vanuxem's broad use of the term Black River has been consistently followed by some writers since, and notably so by the Geological Survey of Canada.

In the first volume of the Paleontology (1847) Hall seems to advocate a quite different use of the term, though he nowhere makes an explicit statement to that effect and there is little evidence that he had any detailed acquaintance with the Watertown section. The most specific statement made is at the bottom of p. 41, where he says that *Murchisonia perangulata* "occurs in a siliceous, cherty mass of the *Birdseye limestone* . . . . near the upper termination of the rock at Watertown." Now there is little or no chert in the Lowville proper and it seems that the reference here can only be to the cherty beds just under the 7 foot tier, which Cushing and Ruedemann mapped with it as a single lithologic unit. If Hall regarded the chert beds as Birdseye he must have restricted the use of Black River substantially to the 7 foot tier.

Since the appearance of Hall's report there has been no use of the term Black River in New York in the comprehensive Vanuxem sense. A usage has grown up however which is not so sharply restrictive as that of Hall, namely that of calling everything Black River which lies between the Lowville and the Trenton. As thus used the term had no precision, since it had not been determined just what was included in the Lowville. Our recent work about Watertown, which we extended so as to include study of the type section at Lowville, gave precise definition to the Lowville formation for the first time.* At the same time a very complicated and difficult nomenclatorial problem was presented. If we included the chert beds with the 7 foot tier as Black River, in accord with present New York usage, and excluded them from the Lowville, as the Watertown sections seemed to suggest we should do, diffi-

* Bull. 145, N. Y. S. M., pp. 79-86.

culties arose in the Champlain sections, and Ulrich urged difficulties without the State, which rendered it impossible to give either of the names Lowville and Black River as wide application as they might otherwise secure. If we adopted Hall's restricted use of Black River we practically wiped it out as a New York name, since the 7 foot tier is thin and occurs only about Watertown. It was finally decided, therefore, that it would be best to revert to Vanuxem's usage (except for the inclusion of the Chazy) and to apply the name Black River to the entire rock group between the Trenton and the Chazy, the usage which the Geological Survey of Canada has consistently followed. The Lowville thus becomes the lower division of the Black River group. The black, cherty beds of the Watertown region, between which and the typical Lowville an unconformity exists, we class provisionally as the uppermost member of the Lowville, and name it the Leray formation, from the river exposures in Leray township, Jefferson county. The section there is, however, not complete. At Lowville, for example, is a thickness of 5′6″ of cherty limestone with *Columnaria halli* and *Stromatocerium rugosum* not seen at Watertown. And to the south, at Newport, in the valley of West Canada creek, this Stromatocerium bed is the sole representative of the formation, the remainder having disappeared.

The Champlain valley seems a wholly separate trough of deposit for these beds. There is present a trifling thickness only of Lowville proper, followed by black, massive beds in much greater thickness than elsewhere in New York. The upper portion of these black beds seems to represent the Leray horizon, and the remainder to bridge the interval represented by the break between the Lowville and Leray in the Watertown sections. The Champlain succession seems unbroken, but deposit did not commence there till late in Lowville time.

The upper subdivision of the Black river group in New York (the Lowville being the lower) is nowhere represented by any considerable thickness of deposit, with the possible exception of the extreme east, where the shales of the Levis channel, overthrust to the west, are met with. Otherwise the deposits are thin, scattered, and of quite varying age, indicating repeated oscillations and prevalence of near shore conditions throughout. In the Watertown sections we group with the 7 foot tier the massive bed below, and the thin one above, into a formation of 13′ thickness which we call the Watertown limestone. It occurs only in the immediate vicinity; and otherwise there is no representative of the upper Black River on the western side of the Adirondack region.

Amsterdam limestone.—There is present in the eastern Mohawk sections and the Saratoga region a limestone of Trenton-ish aspect, which the early geologists were clear-sighted enough to distinguish from the typical Trenton. Conrad called it the Mohawk limestone; but this term was variously used by the different geologists, was hence abandoned in the final reports, and instead the formation was referred to as "base of the Trenton" limestone. The rock is chiefly in the third district, and that most excellent geologist, Vanuxem, discusses it in his chapter on the Black River limestone, with which he classes it notwithstanding the name used.* We propose to call it the Amsterdam limestone. It has of late years been usually referred to as Trenton, both along the Mohawk and at Saratoga, but is older than anything in the type section at Trenton Falls, and is properly referable to the Black River, forming the youngest division of the group in New York. It is also a deposit in a different trough from that of the type Trenton and, during Amsterdam time, the entire western border of the Adirondacks was unsubmerged. The Amsterdam is emphatically a deposit of the eastern and southeastern border only. On the southeast (eastern Mohawk and Saratoga) it rests on the Tribes Hill or Little Falls and is followed by shaly limestones and shales, or simply by shales. In the Champlain valley true Trenton limestone overlies the Amsterdam, though even here only the lower Trenton consists of limestone. In the lower Mohawk region the bulk of the true Trenton consists of shale, with some thin, intercalated limestone bands in the lower portion.

The view here urged in regard to this formation is nothing but the old view of Conrad and Vanuxem, and a new term is proposed for the formation because of the confusion attending the use of the term Mohawk limestone in the Annual Reports, and its ultimate abandonment by the proposers; and also to avoid conflict with Clarke and Schuchert's useful and more comprehensive term Mohawkian.† The type sections are along the Mohawk in the vicinity of Amsterdam.

The shales.—Above the Black River or the Trenton limestones black shales follow, in all the New York sections. In the Champlain region limestone deposit continued through the lower Trenton, but the upper Trenton is represented by shales, with occasional thin limestone bands; in the eastern Mohawk and Saratoga sections the shales follow the Amsterdam, and the entire Trenton consists of shales except for the immediate base which consists of alternating, shale and thin limestone bands; in the western Mohawk sections there is again a

* Geol. 3d Dist., pp. 43-5. † Science, Dec. 15, 1899.

limestone of lower Trenton age followed by shales and thin limestone bands; only in the western border sections (West Canada creek and Black river) did limestone deposition continue through to the end of the Trenton. Much of shaly Trenton has heretofore been called Utica. As the result of recent work Ruedemann has the problem of the age of these shales well in hand, and with most important results.

Paleozoic Submergence of the Adirondack Region.

Some years ago Cushing expressed the view that the entire Adirondack region was submerged during Utica time, basing the opinion on the thickness of the Champlain Paleozoic section (Potsdam-Utica) and the present altitudes of the Precambrian summits of the Adirondacks. The assumption was that the successive seas overlapped ever more extensively on the oldland, without extensive downwarping of the marine troughs. It was further thought that the Utica shale was found on all sides of the region.* Shortly afterwards, and independently, Ruedemann expressed the same view, his argument being that the orientation of the graptolites in the shales indicates currents clear across the region.†

Our recent results cast much doubt on the correctness of these previous views. As the evidence accumulates it points more and more strongly to deposit in downwarping troughs, in which large depth of deposit by no means implies *extensive* overlap on the shores. Usually also deposit on the east side of the region was coincident with sea-withdrawal on the west, and vice versa. Even when submerged at the same time, as in the Trenton, the deposits on the two sides are so different, both lithologically and faunally, as to indicate that the two basins had no very direct connection. Entire submergence of the Adirondack tract during the Utica appears unlikely. It follows that there has been no complete submergence of the area since the earliest Precambrian.

Chart.—In order to present more concisely the nomenclature modifications suggested in this paper, the chart below is hereappended. It makes no pretence of completeness so far as the major division are concerned, giving simply the chief groups into which the rocks present are divided, their subdivisions, and the general sections of the northwest, southwest, south, southeast and northeast borders of the Adirondacks.

* 18th Rep., N. Y. State Geol., pp. 76–7.
† Am. Geol., Feb. 1898, p. 75.

	Watertown region	Trenton Falls	Mohawk valley	Saratoga vicinity	Champlain valley
	Utica shale	Utica shale	Utica shale	Utica shale	Utica shale
Trenton group	Trenton limestone	Trenton limestone	Trenton shale Trenton limestone	Trenton shale	Trenton shale Trenton limestone
				Amsterdam limestone	Amsterdam limestone
Black River group	Watertown limestone Leray limestone Lowville limestone	Leray limestone Lowville limestone	Lowville limestone		Black River limestone
Chazy group	Pamelia limestone				Valcour limestone Crown Point limestone Day Point limestone
Beekmantown group	Tribes Hill limestone		Tribes Hill limestone		Division C, D and E of the Beekmantown Tribes Hill limesto'e (?)
Saratogan	Theresa formation Potsdam sandstone	Little Falls dolomite	Little Falls dolomite	Little Falls dolomite Hoyt limestone Theresa formation Potsdam sandstone	Little Falls dolomite Theresa formation Potsdam sandstone

NOTE.—Parallel lines represent the greater, and dotted lines the lesser unconformities. Unbroken lines represent absence of breaks.