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NEW YORK STATE MUSEUM

CHARLES C. ADAMS, *Director*

HISTORY AND VALUE OF THE NAME "CATSKILL" IN GEOLOGY

BY GEORGE HALCOTT CHADWICK

Temporary Geologist, New York State Museum

CONTENTS

	PAGE
Foreword	5
Introduction	6
Proposal of the names.....	7
1 Catskill Mountain group.....	7
2 "Old Red Sandstone".....	22
3 Montrose and Oneonta.....	25
4 Catskill (in two senses).....	27
Subsequent history of "Catskill".....	33
Overlying strata	33
Upper limit of Catskill.....	37
Underlying strata	40
Lower limit of Catskill.....	44
Subdivision of Catskill.....	61
Renewed field work.....	64
Rectification of correlations.....	70
Claimed absence in New York.....	79
Erroneous statements	88
"Catskill" fossils	90
Summary and interpretation.....	93
Definition	101
Bibliography	101
Index	109

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Bibliography	101
Index	109

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LIST OF ILLUSTRATIONS

	PAGE
Figure 1 Map of southeastern New York, Catskill area.....	4
Figure 2 Locality skeleton, and key map of same area.....	8
Figure 3 Geological map, Upper Devonian of same area.....	9
Figure 4 Geology of Kaaterskill-Phoenicia quadrangles.....	10
Figure 5 Topographic map, Catskill red-beds type area.....	16
Figure 6 View of mountain front, Mather's type section.....	17
Figure 7 Historical chart, terminology of type section.....	58
Figure 8 Historical chart for Oneonta-Franklin section.....	59
Figure 9 Historical map of Catskill red-beds, New York.....	97
Figure 10 Correlations: Cleveland, Ohio, to Catskill.....	99

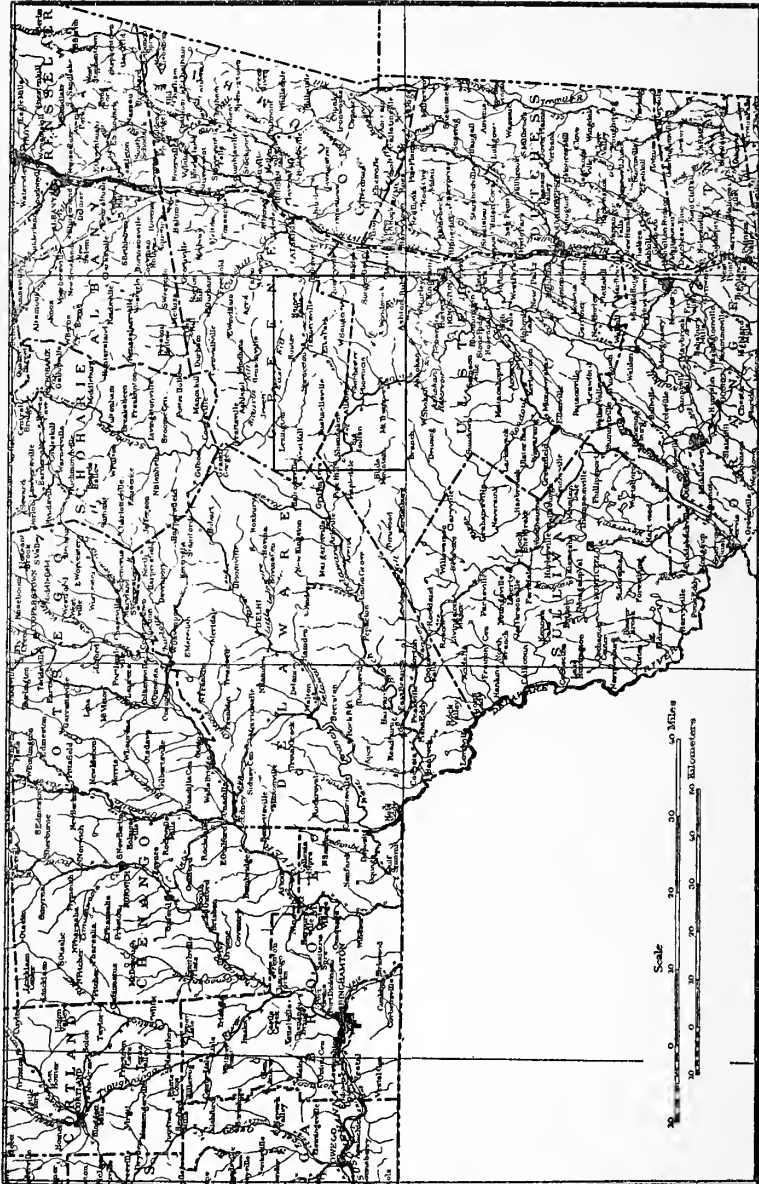


Figure 1 Part of the United States Geological Survey map of New York State, covering the section of the State occupied by the continental (that is, land-deposited) red-beds called the "Catskill" formation. See also figures 2 and 3 of the same area. The area of figure 4 is outlined.

HISTORY AND VALUE OF THE NAME "CATSKILL" IN GEOLOGY

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FOREWORD

Widespread use of the name Catskill for a geological formation (actually for two formations) has drawn favorable attention for nearly a century to that part of the Capital District of New York in which lie the Catskill mountains and Catskill village. But this use has been in many unlike senses, in different areas, and with varying limitations even in the region of origin. The age and classification of these Catskill rocks have remained in dispute from the outset; besides, it has even been argued in all seriousness that there is "no Catskill formation whatever" in New York State—that it is all in Pennsylvania.

Preparation for the New York State Museum, of the manuscript and map for the bulletin on the Catskill and Kaaterskill quadrangles, in which is the "type section" of the Catskill group, has made it necessary to review these controversies and to determine the correct usage to be followed henceforth, with due regard to the historic derivation and value of this name, Catskill, which has also been employed from the start in quite another significance.

Especially is this necessary because these origins lie far back, in the generally inaccessible annual reports of 1839 to 1841, the inability to consult which has led many writers into mistaken statements or premises. Furthermore, we have but recently come to a right understanding of the true age and correlations of these rocks (the "old red sandstones" of Greene county) in our Catskill mountain front, (see figures 3, 6 and 10), the past errors in which have also led writers astray in their conclusions.

From a reputed position at the top of the Upper Devonian (or in the overlying Carboniferous) above the "Chemung" rocks, the Catskill red-beds have been moved down, first to supposed equivalence with these Chemung beds, and now to a known position entirely below the Chemung (in the Catskill mountains proper), reaching even far down into the still lower "Hamilton" deposits. This is but a part of a revolutionary reclassification of the entire Upper Devonian that has been in progress for more than 15 years, to which the writer and others have materially contributed.

It may be well to add that this problem is one with which the writer, a native of Catskill, grew up, and which has followed him through life; further, that he has personal intimate acquaintance with these rocks throughout the entire territory involved, in New York and Pennsylvania, especially in each critical locality that has been mentioned by writers, and is therefore in a position to understand exactly what each writer was describing, as well as to rectify the mistakes.

The order of approach to the problem has been to consider first the introduction of the name, then its varying upward and downward limitations, and age interpretation, in the Catskill area, with its subdivision there, and finally the erroneous notions that have prevailed, especially as to its nonexistence in the Catskill mountains. From this, and a review of the fossil evidence, a conclusion is reached as to its proper definition for future usage. The list of papers given is believed to be exhaustive, not for the geology of the Catskills, nor for the general appropriation of the name "Catskill" elsewhere, but for the vital history of its birth and upbringing in its native haunts. The chronologic arrangement of the list exhibits this developmental aspect of the subject, emphasizing the time of writing rather than the author.

INTRODUCTION

Any intelligent grasp of the contents of this review requires a knowledge of the geography as well as of the geology of the area, which, in lieu of that personal experience that is so desirable, may be partially accomplished by frequent recourse to the maps and sections herewith provided.

As at present known, the Upper Devonian rocks of New York and Pennsylvania consist of a deceptively intergrading and overlapping series of unlike sediments laid down in parallel zones upon a vast delta, partly out of and partly under water. The Catskill beds ("old red") represent a part of those that were formed above sea level, while at the same time the same layers reached out under water, farther west, (see figure 3 and figure 10), and there are not red but are filled with salt water shells and other marine fossils.

As time progressed, and the delta grew, its growth drove the shore line westward, allowing the red-beds to be deposited farther and farther west, on top of the previous marine deposits. This gave the false impression that the red-beds were a wholly later formation, overlying the marine "Chemung" beds. All of the reds, being then supposed to be contemporaneous, and also supposed to be later *in toto*

than the "Chemung," thus came to be called "Catskill." That the higher or later reds are confined to more western areas, and would pass eastward only high in air above the Catskill summits, has been a delayed discovery. Attention is drawn, therefore, to the diagram (figure 10) showing these perplexing relationships. Only the lower and older of the red-beds are present in the Catskill mountain region. Between these and the later reds of farther west it is now possible to discriminate by sharp stratigraphic and faunal lines. How much, then, does this name; Catskill, rightly cover?

PROPOSAL OF THE NAMES

1 **Catskill Mountain group.** In 1840, Lieutenant William Williams Mather, geologist of the "first district," which included the eastern Catskills, reported on the rocks of these mountains as follows, on page 212 (*italics his*):

"(4.) The *Catskill Mountain group* terminates the series of *indurated rocks* in the First District. This group consists of white, gray and red conglomerates, with gray, red, olive and black grits, slates and shales. Some of the strata in the lower half of this group, abound with the impressions and casts of fossil shells, while those of the upper half contain the impressions and casts of numerous plants, some of which are similar to those of the coal beds of Carbon-dale." This description immediately follows that of the "(3.) Helderberg group" in the "B. Fossiliferous series of Rocks," and is in turn followed by the "tertiary." On the following page, under "Topographical character," he says:

"The *Catskill mountain group* forms the high mountain region of Greene, Ulster, Sullivan, Delaware and Schoharie counties."

On pages 227 and 228, under the heading "IV. CATSKILL MOUNTAIN SERIES" (instead of "group"), he describes these rocks as follows (*italics his*):

"The next group of rocks in the district under examination, and the most recent of the consolidated formations, is that which lies between the Helderberg limestone series, and the coal bearing rocks of Carbon-dale in Pennsylvania. It contains the 'olive sandstones,' 'dark coloured shales,' and 'black slate' of groups 8 and 9 of Mr. Conrad's Report of 1839; and formations viii.ix.x. and xi. of Professor Rodger's Report on the geology of Pennsylvania for 1838, viz: the part of the 'olive slates' above the limestone formation, the 'red sandstones and shales,' the 'sandstones and conglomerates,' and the 'red shale of the anthracite coal regions.'

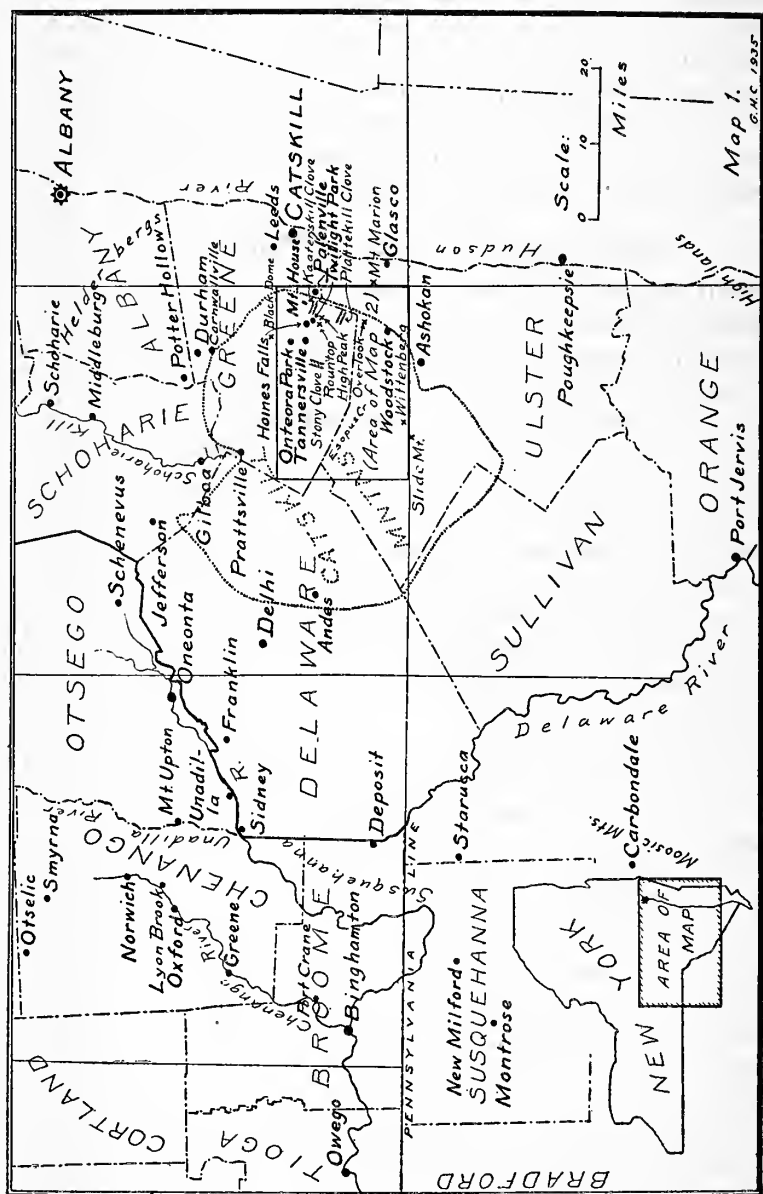


Figure 2 Skeleton map of the same area as figure 1, showing the important localities (including all that are mentioned in the text) and the limits of the Catskill Mountain ranges (dotted line). The heavy black line between counties separates Vanuxem's (or the "Third") district, on the northwest, from Mather's ("First") district, on the southeast. Area of figure 4 is outlined, as on figure 1. A key map is added, in lower left corner. For the geology of this area, see figure 3, facing.

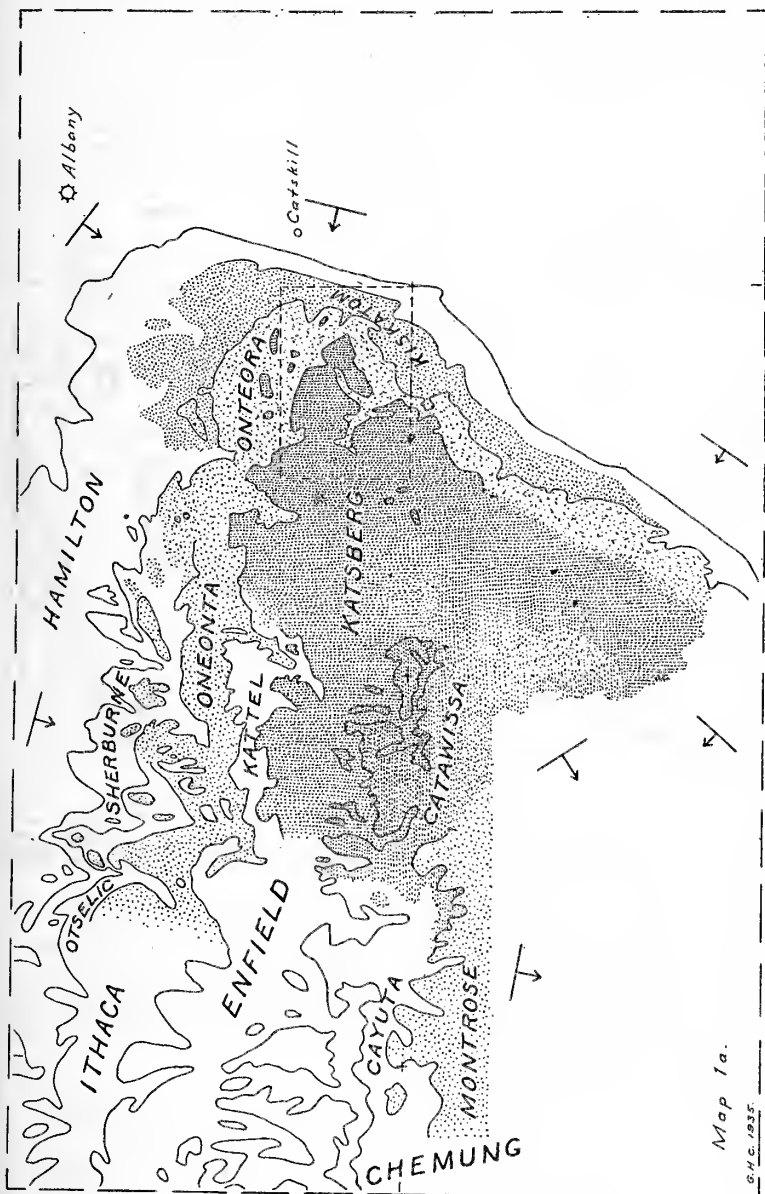


Figure 3. Geological formations (above the Onondaga limestone) of the same area as figures 1 and 2, showing by stippling of various patterns the (land-deposited) red-beds called Catskill and the named subdivisions of these red-beds, together with the equivalent marine formations (sea-deposits), in white, to the west. Dip (slope) of the beds, shown by the arrows. Limits of the Catawissa and Katsberg divisions not yet determined to southeast. The map shows the error in confusing Oneonta beds with Montröse, Kattel with Chemung, Kiskatom with Oneonta, and so on.

"The Catskill mountain series consists of coarse and fine grits, grayish, greenish and various shades of red and brown, which lie thick bedded, with water lines of deposition strongly marked where a cross fracture exhibits the structure; conglomerates of various degrees of coarseness, grayish, greenish and red; slaty sandstones,

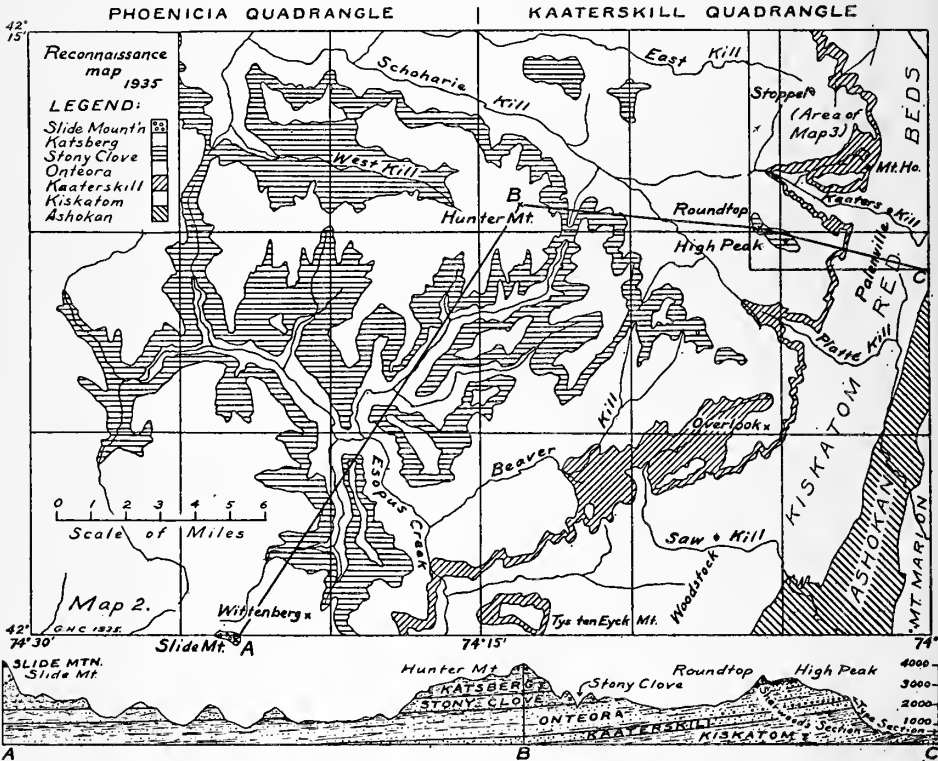


Figure 4 Preliminary geological map of the Phoenicia and Kaaterskill quadrangles (for area covered see figures 1, 2 and 3) with cross section on line A-B-C from Slide mountain through Hunter mountain (line bends here) and Roundtop showing the dip of the beds (with coarsening eastward), neglect of which caused miscorrelations from range to range. Area of figure 5 is outlined (northeast corner). All of the formations shown on this map are continental (land-deposited) except the Mount Marion beds of the Hudson valley in southeast corner, and all of these are "reds" except the Ashokan, Stony Clove and Slide Mountain beds.

with slates and shales of various colours, as red, green, spotted, gray and black.

"Testacea are the principal fossils of the lower, and plants of the upper portion of the series.

"The general arrangement of parts of this series is

1. Conglomerates and coarse grits.
2. Red shales, slates and grits.
3. Gray slaty grits.

4. Chocolate grits with red shales and slates.
5. Gray grits and bluish shales, among which are the flag stones.
6. The olive slates and shales over the Helderberg series. [Turning to page 228.]

"This formation occupies the county of Delaware, and by far the largest portions of the counties of Sullivan, Ulster, Greene and Schoharie. Seams and layers of pure anthracite have been observed in some places, and fossil plants similar to those of the coal beds of Carbondale have been found, not only in the shales associated with the anthracite, but also abundantly in the grits and slaty sandstones of the middle and upper parts of the series. These strata are all, perhaps, below the coal bearing rocks of Pennsylvania, and it is not considered probable that coal will be found in useful quantity in them; still, some parts of the upper portions bear so much resemblance to the anthracite coal rocks of Pennsylvania, both in mineralogical character and fossil remains, that it is thought *possible*, that coal beds of workable thickness may be discovered.

"The Catskill mountain group is exceedingly barren of useful minerals."

There is nothing in Mather's pages to justify Merrill's interpretation (table in New York State Museum Bulletin 56; 1902) that Mather used "Catskill Mountain series" and "Catskill Mountain group" in two different senses, the latter only from the Tully limestone up. This may be a confusion with Emmons 1846.

It will be observed that in this, its first known publication, the "Catskill Mountain" group or series was an inclusive term, embracing locally the Bakoven, Mount Marion and Ashokan formations at bottom (see figure 7, and figure 10) as well as all the succeeding strata through the entire Catskill region and into Pennsylvania to the base of the Pottsville, namely the Kiskatom, Onteora, Katsberg and Catawissa red-beds of our present nomenclature, and explicitly also the Pocono ("No. x." or "Vespertine" as identified east of Carbondale, Pa.), later often called "White Catskill," and the supposed "Mauch Chunk" ("No. xi." or "Umbral" as identified east of Carbondale), a red shale at its home locality but not red (and not actually Mauch Chunk) around Carbondale.

These limits are specific and unmistakable: from the top of the Corniferous (now called the Onondaga) limestone of the Upper Helderberg group, to the top of the Pocono (including false Mauch Chunk) of the Moosic mountains, the age of which is upper Chemung (Montrose). They embrace exactly the Erian (Hamilton) and Senecan (Genesee, Naples and Chemung), as now classified—and nothing higher. They comprise marine as well as continental beds, at Schoharie, Catskill and southward—Middle as well as Upper

Devonian. Only in part are they red-beds, and the idea of such a connotation is not in the original definition. Neither top nor bottom is red.

The historical charts, figures 7 and 8, should be constantly consulted in following through this history of the name.

In the following year (1841), Mather extended his description of these strata, on pages 75 to 85, under the caption "CATSKILL MOUNTAIN SERIES," in part thus:

"This series is the next in order of geological superposition, below the drift and tertiary deposits in the First Geological District of New-York [page 76]. The upper portion of this series, is the highest in geological position, of any of the indurated rocks of the State, (except some local consolidated gravel beds of drift;) but the highest of the Catskill Mountain rocks are below the coal formation of Pennsylvania, and reach only to its base.

"The Montrose sandstone of Prof. Vanuxem is below the top of this series in the Catskill Mountains [see the explanation on page 30, beyond], and beneath this, nearly all the strata described by him in his last report are found, characterized by their peculiar fossils; but these rocks in the First Geological District are generally of a coarser texture, down to the Helderberg limestone series, than in the Third District, and the fossils are as rare comparatively in this, as they are abundant and beautifully preserved in the other.

"In many of these strata, the fossils had entirely escaped observation, in consequence of their rarity, until, when in company with this gentleman, he recognized the particular strata he had described, and then, by careful examination, we found the characteristic fossils.

"Marine testacea are the most numerous fossils in the lower, and marine and terrene plants in the upper part of this series.

"The formation occupies but a limited area in the region that has been under examination the past year. It occupies the town of Rensselaerville, and most of those of Westerlo and Bern, in Albany county. This is the northeastern extremity of that formation, and each stratum at its outcrop to the north and east, occupies a terrace of greater or less breadth. . . ." Continuing on page 77:

"The strata of the Catskill Mountain Series occur in the First Geological District, in the following groups [this list of divisions is evidently based on the Schoharie valley section, not on that of the Catskill front], viz:

1. Conglomerates and grits.
2. { Red and gray grits with red shales mottled with green spots.
Montrose sandstone, of Prof. Vanuxem.
3. Chemung group of Prof. Vanuxem.

- | | | | | |
|----|-------------------|---|---|---|
| 4. | Ithaca | " | " | " |
| 5. | Sherburne flags. | " | " | " |
| 6. | <hr/> | | | |
| 7. | Hamilton group. | " | " | " |
| 8. | Marcellus shales. | " | " | " |

"Some of the groups of rocks described by Prof. Vanuxem, are wanting in the First District, or are so thin, or without showing their fossils, as not to have been recognized.

"The following detailed section gives the rocks as they can be seen in the Catskill Mountain Series, from the top of the South mountain near the Mountain House, at the Pine Orchard, down to the Helderberg limestone series at Catskill creek, by the stone bridge, between Catskill [page 78] village and the Mountain House. They are grouped as they occur in terraces, which are numbered from the church in the valley, to the toll-gate at the immediate base of the mountain, and thence up the mountain to the shanty in the ravine. [See figures 5 and 6, herewith].

Geological Section from the summit of the Catskill mountain, south of the Mountain House, to Catskill creek.

- | | | |
|----|---|----|
| 1. | { Gray slaty grit containing some pebbles,..... }
{ Conglomerate of white and red quartz pebbles, intermixed }
{ with those of gray slaty grit,..... } | 40 |
| 2. | { Brown slaty grit,..... }
{ Gray slaty grit, very thin (one to two feet,)..... }
{ Conglomerate about 25 feet thick, exposed,..... } | 30 |
| 3. | O ————— No rock seen, covered with debris,..... | 40 |
| 4. | { Gray grit with some pebbles,..... 8 feet, }
{ Bluish shale, (local merely,)..... 1 foot, }
{ Gray grit,..... 8 feet, }
{ Gray grit, with some pebbles,..... 20 " } | 37 |
| 5. | Red shale down to Table rock at Mountain House,..... | 50 |

Table Rock, on which the Mountain House stands.

[The following list is in single column in the original.]

- | | |
|--------------------------------|--------------------------------|
| 1. Gray slaty grit. | 8. Greenish gray grit. |
| 2. Red shale. | 9. Brownish grit. |
| 3. Brown grit. | 10. Red shale (thick stratum.) |
| 4. Red shale. | 11. Brownish red grit. |
| 5. Gray grit. | 12. Brownish red shale. |
| 6. Red shale with green spots. | 13. O ————— No rock seen, |
| 7. Brown grit. | covered with soil. |

- | | |
|--|--|
| 14. Brownish red grits and shales. | 38. Greenish gray grit. |
| 15. Reddish gritty shales, (green spots.) | 39. Red shale. |
| 16. Red shale. | 40. Green shale. |
| 17. Greenish gray grit. | 41. Reddish brown grit. |
| 18. Reddish brown shale. | 42. Brownish red shale. |
| 19. Greenish gray grit. | 43. Red shale. |
| 20. Reddish grit. | 44. Greenish brown shale. |
| 21. Red shale. [Page 79 follows.] | 45. Gray grit. |
| 22. Brown grit. | 46. Reddish shaly grit. |
| 23. Red shale. | 47. Brownish red slaty grit. |
| 24. Gray grit. | 48. Green shale. |
| 25. Red slate, spotted with green. | 49. Red shale. |
| 26. Red shale. | 50. Brown grit. (Band one foot thick.) |
| 27. Brownish red grit, (contains fucoids.) | 51. Red shales with green bands. |
| 28. Red shale, with green spots. | 52. Brownish gray grits. |
| 29. Gray and red slaty grits. | 53. Brownish red shaly grits. |
| 30. Brownish shale. | 54. Reddish grits. |
| 31. Red shale. | 55. Greenish gray slaty grits. |
| 32. Brownish red slate. | 56. Brown and greenish grits. |
| 33. Greenish shale. | 57. Gray laminated grits. |
| 34. Red shale with green spots. | 58. Red crumbling grit. |
| 35. Brownish red shale. | 59. Reddish slaty grit. |
| 36. Greenish gray grits. | 60. Red shale. |
| 37. Red shaly grit. | 61. Green shale at the shanty in the ravine. |

- [Page 80]. { 60. Red shale, . . . } These two strata are the same as
 { 61. Green shale, } the two preceding, and are
 crossed again, in rising, and
 descend again from the shanty
 in the ravine.
- Terrace 18. { 62. Red shale.
 { 63. Reddish gray slaty grit.
 { 64. Red shale.
17. { 65. Gray grit.
 { 66. O ——— no rocks seen, soil, &c. cover them.
 { 67. Red shale.
 { 68. Greenish gray slate.
 { 69. O ——— no rocks seen, soil, &c. cover them.
 { 70. Red shale with green spots.
16. { 71. Gray grit.
 { 72. Red shale with green spots.
 { 73. O ——— no rock visible.
15. { 74. Greenish gray slaty grits.
 { 75. Greenish gray shale.
 { 76. Gray slaty grits.

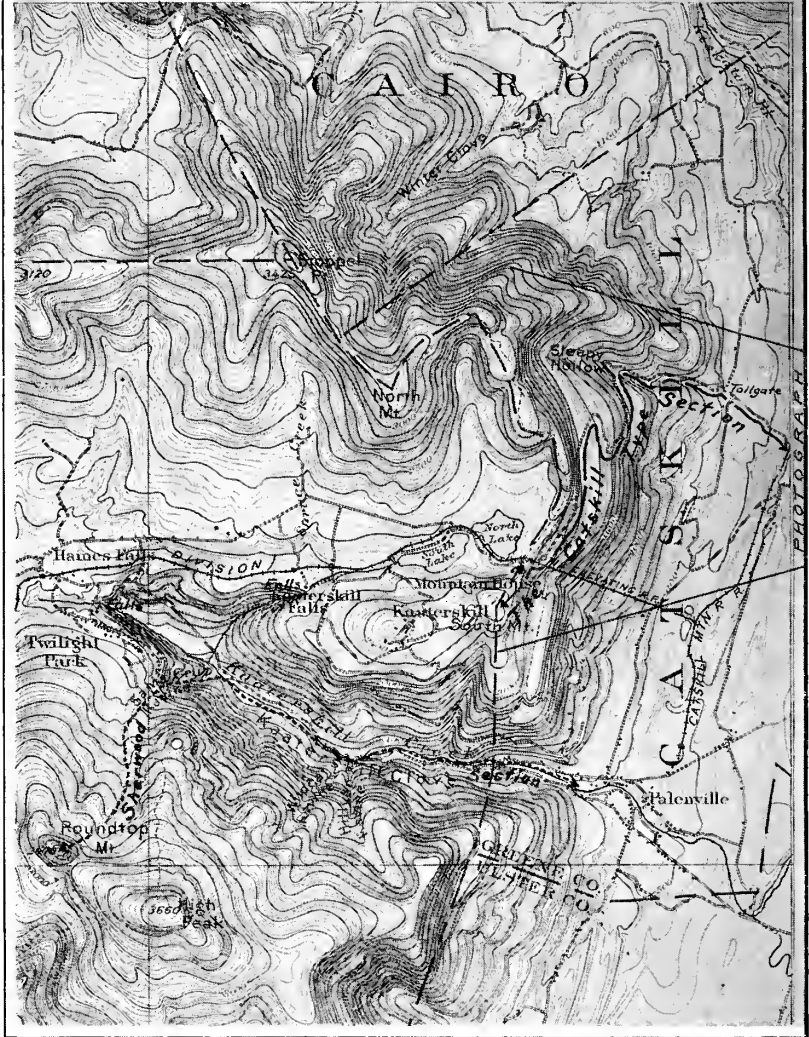


Figure 5 Northeast part of the Kaaterskill quadrangle, showing the location of Mather's type section of the Catskill division, and (approximately) of Sherwood's measured section from the summit of Roundtop to Palenville. (Slightly reduced from original.) The spreading lines inclose the area of figure 6.

Roads and buildings have been considerably changed from this map (1903).



Photograph by E. J. Stein

Distance about four miles

Figure 6 View of Mather's *type section* of his "Catskill division" of 1843, looking west from Schenck farm, on the Mount Marion range $4\frac{1}{8}$ miles west by south of Catskill, and covering the area within the spreading lines on figure 5. Mather's detailed section (white line) starts on the mountain summit to left (south) of the Catskill Mountain House on the skyline, and continues diagonally down to right, following the old stage-road, into the ravine (Rip Van Winkle Clove, or "Sleepy Hollow" of the topographic map, figure 5) at right of view, where it bends abruptly toward us and descends the north side of the ravine to the mountain foot. Note the horizontal ledges and terraces in the mountain front (the "wall of Manitou") as brought out by the light snowfall.
(Type section of the Kiskatom red-beds.)



Fig

14. { 77. Gray slaty grit.
78. Red and brownish red shales.
79. Gray grit.
80. Red and green shales alternating.
81. Brown slaty grits.
13. { 82. Red shale with green spots.
83. Greenish gray grit.
84. Red crumbling grits.
12. { 85. Red and green shales.
86. Gray slaty grits and shales.
87. Brownish shale.
88. Red shale with green spots.
89. Gray shale.
90. Red shale. *To the toll gate.*
11. { 91. Green shaly grits.
92. Greenish and brownish shales.
10. 93. Gray grit, laminae of deposition distinct.
9. 94. Gray grit, do do do
8. { 95. Gray shale.
96. Grayish green shale.
97. Red and green spotted shale.
98. Gray grit laminated.
99. Brownish red shale.
100. Gray grit.
101. Brown shale.
102. Red shale.
103. Brown sandstone.
7. { 104. Red shale, green spots.
105. Gray slaty grit, to bottom of valley. [Page 81.]
6. { 106. Brown slaty grit.
107. Gray slaty grit.
108. Blue slaty grit.
5. { 109. Red slaty grits with shales interlaminated.
110. Bluish gray slaty grit.
4. { 111. Gray slaty grit.
112. Brown crumbling grit.
3. { 113. Gray crumbling shale.
114. Red and green spotted shale.
115. Brown crumbling shale.
2. 116. Gray slaty grit.
1. { 117. Gray slaty grit, *to Kiskatamine creek, at the church in the valley.*

- 1'. { 118. Gray slaty grit.
119. Limestone, brecciated and conglomerate, two feet.
120. Gray slaty grit.
- 2'. 121. Gray slaty grit, laminae of deposition distinct.
- 3'. { 122. Dark shales and shaly grits and flags, of several hundred feet in thickness, embracing from the Ithaca group to the Marcellus shales of Prof. Vanuxem.
- 4'. { 123. Marcellus shales, . . . } At the stone bridge Caters-
124. Helderberg limestone, } kill creek."

Then follows a paragraph that is most interesting, because it contains the first, though perhaps an inadvertent, use of the name "Catskill" in that shortened and now current form. This is on page 81, as follows:

"The strata embraced in 122 have not been traced out in detail as those above have been. Subjoined is a local section of a small portion of the Catskill Series, at Post's Mills, in Durham, Greene county." (The section is quoted beyond, page 27, under "Catskill group.") The succeeding paragraph, page 82, continues:

"Fucoids are found in these rocks, as also in a large portion of those in the section of the Catskill mountain, from No. 1 to 121. Shells and terrene plants are found in the strata embraced in No. 122. The strata embraced in a brace in the section form a terrace. The strata above the shanty in the ravine half way up the mountain on the road from Catskill to the Mountain-House, are not grouped on the section into terraces, on account of the difficulty of defining their limits in ascending along the road, which is, of course, made in the most favorable location; but at a distance from the mountain, when the eye can observe a greater area, the mountain is seen to be divided into regular terraces to its very summit." [See the photographic view, figure 6.]

Then, closing the next paragraph: "The series is capped by a quartzose conglomerate, which may be seen well developed on the South mountain, south of the Mountain-House." The remaining three pages explicitly include many localities of Marcellus and Hamilton exposures as a part of this series, herein twice spelled "Cattskill."

Mather oddly stops his section short on the summit of South (or Pine Orchard) mountain, over a thousand feet below neighboring

summits, while at the same time he affirms that the series extends to the tops of the highest peaks in the Catskills, then believed to be (as above quoted) the "highest indurated rocks of the State," and reaching (but "only") to the base of the coal formation of Pennsylvania. Of course, at that early day, Mather's information in these matters was deficient; but it is clear from the above excerpts that he intended no change in limits from his previous definition of this series, the uppermost member of which is still composed of "conglomerates and grits." Two years later he had a different conception of these.

Mather's carefully elaborated columnar section above copied is unique for those days, unmatched in these early reports and a model even for today. It lies entirely within the bounds of our quadrangles, following the now disused old "Mountain road" of 1823 (see figures 5 and 6) from Kiskatom Dutch church (burned in 1928 and rebuilt on the same site) at the irregular four corners 1.3 miles west-northwest of "Kiskatom" of the Catskill quadrangle map, [the less abbreviated form Kiskatamine (kis-ka-tom-in-ee) is used by Mather], westward via the "Sleepy Hollow" (Rip Van Winkle Clove) to the Mountain House (Beach's), then southward by the "front" path up South mountain a quarter of a mile to its summit, 2,450 feet above sea level. Anyone can retrace Mather's route from that summit down past the "shanty in the ravine" (later enlarged into the "Rip Van Winkle Hotel" and now fallen to dust) at the sharp reentrant, past Kiskatom church and Kiskatom, to the Webber bridge, replacing upstream the former "stone bridge" over the Kaaters Kill on the present Catskill-Tannersville concrete highway (number 23-A) or "Rip Van Winkle trail." This section is again referred to beyond.

The name "Catskill Mt. Rocks, or Red Sandstone" was the form employed for the Catskill red-beds in the legend of the Geologic Map of New York of 1842 and on its reprint as the "Agricultural and Geological Map" of 1844, while on the accompanying "Section from Jones Beach L. I. to Oneonta" the word "Old" is prefixed to "Red Sandstone" and on two other sections the name is simply "Old Red Sandstone" (without mention of Catskill), these two sections terminating in Pennsylvania, one of them at Blossburg. "Catskill mountain [or Mt.] group" was also used several times by Mather in 1843 in his final report (page 316 and explanations of plates, and on the plates themselves, which had probably been engraved before the change to "Catskill" was decided upon). "Catskill mountain group" was used by Professor James Hall, our State Geologist, solely (except "Catskill group" once) in 1859, once on

page 52 and thrice (in the hyphenated form, "Catskill-mountain") on page 53, including explicitly both "ix" and "x" (the Pocono) of the Pennsylvania survey. In 1861, Ledyard Lincklaen lapses once (page 62) into "Catskill mountain group" and (page 70) speaks in quotation marks of "these 'Catskill mountain strata'," and thereafter Hall occasionally relapses into the old form, as in 1864 (page 307): "Catskill mountain group," 1870 (page 565): "Catskill Mt. Sandstone," 1879 (page 13): "Catskill mountain formation," 1880 (page 290): "Catskill Mountain sandstone," and 1883 (page 53), in a paper read in 1857, as "Catskill mountain group." Otherwise it soon dropped out of the literature, and "Catskill" supplanted it but with a changed embrace, being in fact actually a new stratigraphic name.

2 "Old Red Sandstone." Earlier by a year than Mather, one of his colleagues, Timothy Abbott Conrad, had in 1839 referred all these rocks to the European "Old Red Sandstone Group" of the English geologist Sir Roderick Impey Murchison, and with specifically the same downward limit as Mather after him adopted for his Catskill Mountain series, namely the base of the (Marcellus) "black slate." Omitting the lists of fossils, the upper part of Conrad's table, on his page 62, reads as follows (*italics his*):

"10. Carboniferous strata, (in Pennsylvania).

ROCKS OF NEW-YORK.

OLD RED SANDSTONE GROUP, (*Murchison.*)

Old Red Sandstone?

9. { Olive sandstone, (organic remains undetermined, except a few
land plants, very rare.)
8. { Dark coloured shales.
Black slate.

MEDIAL SILURIAN STRATA."

This last covers the Helderberg succession of strata, and so forth.

Conrad says (page 61) that he drew up this table "chiefly from observations made during the first year of the survey," at which time he was a district geologist, though thereafter the paleontologist for the whole survey, and since the Portage olive sandstones are the highest rocks he would have seen in the territory then assigned to him (see the map, plate 1, in Merrill, 1902) it is safe to say that his "9" is essentially the entire Senecan, as "8" is plainly the Erian.

No red rocks are described by him in this "old red" group, yet he doubtless knew (as did Mather) that red rocks lay on above these Portage and Chemung "olive sandstones" and below the coal fields of Pennsylvania. [Conrad's acquaintance with Richard Cowling Taylor must already have familiarized him in 1839 with Taylor's recognition of the "old red" at Blossburg, Pa., which Conrad himself described in 1841 and 1842. It is stated by Jules Marcou, 1858, (see Stevenson, 1892, page 6) that as early as 1831 Taylor had published a paper on the relations of the "old red" to the Carboniferous.] Thus Merrill's interpretation of Conrad's table (in the folded chart already mentioned) puts the "Old red sandstone" as the top member of the group (above "9"); but it is uncertain whether Conrad so intended it or whether he meant it to be a queried equivalent of either "9" or perhaps both "9" and "8," since he indents, italicizes and does not number it. If, however, Conrad meant to give it separate place, as Merrill thought, then such red beds as it designated would be post-Chemung.

It is this tabulation of Conrad's to which Mather alludes in the 1840 report as above quoted. But, curiously, Mather omits any reference whatever to the "old red sandstone" and assigns only the three other components to his proposed Catskill Mountain group. This omission may be significant in adjudicating the scope of the name Catskill, as it relieves us of any embarrassment as to the upper limit and of any excuse for calling any post-Chemung beds by that name.

Merrill's inclusion (*loc. cit.*) of "old red sandstone" among the names used in the same year (1839) by Hall appears to be a slip. The next year (1840), however, Hall began, at first hesitatingly, to use the term in a variety of shapes ("old redsandstone," "Old Redsandstone," "Old Red Sandstone," "Old Red system") on pages 393 to 395, and especially 397, with reference to red sandstone beds on the Tioga river in Pennsylvania, "seven or eight miles south of the State line, . . . about 400 feet thick, brick red in color, with beds of softer or shaly rock of the same color, and . . . fucoids and bones of fishes," to which he presently (footnote to page 453) applies the name "the sandstone of Blossburgh." [Hall says (page 393): "To Mr. Taylor is due the credit of pointing out the existence of this rock, and its analogy to the old redsandstone of Europe."] Two years later, Conrad defined "the red sandstone of Blossburg" as the third or upper division of the Devonian system in North America. This Blossburg sandstone, and all the other red rocks to which, in western New York, Hall continued to apply

the name of old red sandstone, are all of later age than Mather's Catskill Mountain group and are above the Chemung as Hall (pages 452, 453) stated. Indeed in his final report of 1843 (like Emmons in 1842) Hall excluded them from the New York System, making of them a distinct and later "Old Red System." In 1841, Conrad had similarly excluded (page 41) the "Old Red Sandstone, or Devonian System" from his Silurian System, but his "Old Red" included in it by name the Chemung group as well as "the red sandstone near Blossburg," a fact that Merrill (1902) overlooked.

In all this procedure there is nothing to justify extension of Catskill to any beds above the Chemung. It is to be noted, moreover, that Hall in his final report of 1843 (pages 278 to 283) did not even once extend the name "Catskill" over his district of western New York but adhered strictly to the designation "Old Red Sandstone" for these rocks of post-Chemung age; pages 17, 19, 276, 277, 285, 292, 482, (487), 517, 524, 658, 677, 679, map, section and plates. That on pages 6, 19, 22, and 278 to 280 he comprised the rocks of our Catskill mountains "in part or the whole" also in the "Old Red" (a correlation that he credits to Professor Amos Eaton, 1824, as of page 92 of the "Canal Rocks") appears to have been in deference to his colleagues, since he says in 1873 (page 7) that "the nomenclature was, after all the investigations, a compromise among those occupied in the work"; and the same may be true of the two times (pages xxv and 20) that he actually employs "Catskill" in a stratigraphic sense, but followed immediately by "or Old Red Sandstone," and not making it to apply to western New York, and of his inclusion of "Catskill" in the synonymy on page 278. But (page 277) he would exclude the Chemung from this Old Red.

Up to the close of the labors of the geologists of the original New York Survey, in 1843, therefore, only the names "Old Red sandstone" and "Blossburg" had been applied to Devonian red rocks of later age than Chemung in New York and Pennsylvania. And this must be emphasized in as much as it is quite another thing that the Chemung and pre-Chemung red rocks of the Catskill Mountain group farther east had also, and correctly, been correlated as of "old red" age, for the typical "Old Red" of the British Isles comprehends a wide time range as do our American red equivalents. The Catskill is but a part of the "Old Red" red-beds. Thus, Charles Callaway, coming to us from northern England, said in 1878 (page 43): "The Catskill group is sometimes called by American geologists the old red sandstone, a term which, if used at all, should be applied to the entire Devonian system."

3 **Montrose and Oneonta.** In 1840, in the same report in which Mather defined his Catskill Mountain series, Professor Lardner Vanuxem proposed (page 381) two different names for two distinct formations that he believed to be identical, and to overlie the Chemung, though he was doubly mistaken. He says:

"Montrose sandstone, or sandstone of Oneonta; this is the last or upper rock of the third district [central New York]; it consists of many veins of gray sandstone, and sometimes of red sandstone; when weathered it exhibits a peculiar structure, to all appearance owing to the manner in which it was deposited from water; in this rock we often find the remains of terrestrial plants, and sometimes they are thrown together in such numbers as to form a thin mass of coal, extending for a few feet, but only an inch or more in thickness; this rock is found in Otsego, Chenango and Broome counties; it covers the whole of the upper part of Susquehanna county, in Pennsylvania, and being there an abundant rock, and surrounding the town of Montrose, I have thought it well to apply its name to this rock."

The rock strata that cover all but the deep northern valleys of Susquehanna county, Pa., appertain to the Wellsburg or upper member of the true Chemung in its continental (or red-beds) facies, beneath which the lower Chemung (Cayuta) is still largely marine. These Montrose reds enter the extreme south edge of Broome county, where their presence and their Wellsburg age, as in southern Tioga county (New York) also, are affirmed by Professor Henry Shaler Williams in United States Geological Survey Folio 169 (page 82). The red rocks and cross-bedded gray sandstones of Otsego and eastern Chenango are a much lower mass, for which Vanuxem's name of Oneonta beds has now come into general use, and which lies not only below the Chemung but also below the subjacent Enfield beds so often later mistaken for Chemung. In the following report (1841), Vanuxem does not again mention these strata, and Conrad (page 31) applies "Oneonta" to marine shales (of Genesee or perhaps lowest Ithaca age) beneath the continental sandstones so named by Vanuxem. In his final report of 1842 (page 186), Vanuxem put both of his names "Montrose and Oneonta" as synonyms under "Catskill group." The explanation of this was given by Hall in 1893 (page 33), who says:

"One of the most notable and interesting questions in discussion at the close of the survey, had reference to the Oneonta sandstone and its relations to the Chemung and Catskill groups. In the later discussions upon the subject by the New York State geologists, and

in their final meeting to adjust the nomenclature no satisfactory solution of the difficulties surrounding this subject was reached.

"The Oneonta and Montrose sandstones of the annual reports of Mr. Vanuxem were in his final report merged in the 'Catskill group,' and the most characteristic fossil which lies at the base of the Oneonta was designated as *Cypricardites Catskillensis*." In 1880 Hall stated: "In the final arrangement of the nomenclature of these rocks, the observations of Mr. Mather in Delaware and Ulster counties led to the adoption of the term Catskill sandstone, or Catskill Mountain sandstone, for the whole, including the Oneonta and Montrose sandstone of Vanuxem, under the belief that the rocks as exposed in the several localities constituted parts of, or different exposure of, a single formation. This view has been accepted in all subsequently published observations, and universally believed to be the true one." In the 1870 report of the State Cabinet, published in 1873, Hall wrote, on page 7, that the nomenclature adopted was a compromise and that "Mr. Vanuxem . . . yielded to Mr. Mather's views in the more difficult and inaccessible country bordering the two districts, and the name 'Catskill' superseded the 'Montrose and Oneonta sandstone' of the Annual Reports." The name Oneonta appears to have lain dormant until resuscitated by Hall in 1870, whereafter for a quarter of a century these beds became the subject of intensified study in the field.

The name Montrose also came up for reconsideration at that time (1870). But in 1881, Dr Israel Charles White in reporting on the geology of Susquehanna county, Pa., (pages 67 to 68, and 115) alludes, but inaccurately, to Vanuxem's term that is so perfectly fitted to and correctly defined for the Wellsburg reds, and presumes to give the same name to two lesser divisions of his own making, "Montrose sandstones" and "Montrose red shale," of which the latter at least does not fit his description of it and neither one merits such magnification.

It has been noted above that Mather in 1841 (page 76) asserted that the Montrose sandstone is below the top of his Catskill Mountain series "in the Catskill Mountains," which is not true in New York but is true there of the Oneonta, its supposed representative. (See figure 3.) Mather (page 77) also makes the Montrose synonymous(?) with his second member (from the top), or the whole of the red-beds portion of his series, and resting on the Chemung, which last is true only in Susquehanna county, Pa.

4 **Catskill.** This name, antedated by all those above given, with none of which it is identical in meaning, was first used in 1841, by Mather as already related; on page 81, he gives the following "local section of a small portion of the Catskill Series, at Post's Mills, in Durham, Greene county.

	Ft.	in.
"1. Gray grit at the top of the ravine, surface rock.		
2. Red shale,.....	4	0
3. Greenish grit,.....	20	0
4. Red grit and red shale,.....	15	0
5. Hard band of red grit,.....	2	0
6. Red shale,.....	2	0
7. Hard band of red grit,.....	2	0
8. Slaty red grit,.....	2	0
9. Red gritty shale,.....	4	0
10. Greenish gritty shale,.....	3	0
11. Reddish slaty grit,.....	7	0
12. Green band of shale,.....	1	0
13. Red gritty shale,.....	5	0
14. Blue limestone, compact,.....	0	6
15. Red shale, and thin band of slaty grit,.....	8	0
16. Slaty sandstone, some spotted with green,.....	6	0
17. Green shale, and bands of red grit, unknown thickness.		
	—	—
	81	6

Continuing on page 82:

"The stream at these mills has cut a deep ravine or gorge, with sides that are perpendicular in some places, and a fine view of these rocks is thus exposed. Fucoids are found in these rocks, . . ."

Roswell Post built his mill, before 1790, on Post's creek at the point now known as "Shady Glen," about one mile northeast of Cornwallville (or two and a half miles above East Durham) and two miles out from the foot of the Catskill mountains. The rocks in the glen are Hamilton (Kiskatom) red-beds, of the age of the Ludlowville member. To these Hamilton reds, then, the name "Catskill" was first applied. For present purposes this possible inadvertence of Mather's was perhaps fortunate, for the next use of "Catskill" was by Vanuxem (in 1842) for the Lower Devonian formation later and currently called the New Scotland limestone. Vanuxem introduced further confusion by using "Catskill" also, in the same volume and two times even on the same pages with the limestone, to supplant his former "Montrose or Oneonta," as previously noted. The quotations follow.

From page 6 of Vanuxem's final report on the third district (1842), in the table of contents: "15. Catskill shaly limestone, Delthyris shaly limestone, and Scutella limestone of the Reports." On page 7: "28. Catskill group, Montrose and Oneonta sandstone of the Reports, Old redsandstone of England." On page 12, in the list of formations: "17. Catskill or Delthyris shaly limestone," and "30. Catskill group, or old redsandstone." On page 13, in the table: "Catskill shaly limestone" and also "Catskill group," changed lower down to "5. Catskill division." Finally the two are defined. On pages 120 to 122 the "CATSKILL SHALY LIMESTONE" is described and is said to be named "from Catskill creek, in the first district, near the town of Madison, Greene county, by the side of the railroad, where for a long distance it is exposed to great advantage for examination. The name is objectionable, but it is no easy matter to find one in the State which will be less so." (Madison is now Leeds; and two railways have come and gone in this postglacial gorge of Austin's glen—the Canajoharie and Catskill then, the Catskill Mountain railway a half century later.) Thus early was the finding of appropriate names already troublesome! Surely none could be more appropriate than this one, though Vanuxem reached out into another man's district for it, with consequent embarrassment to that other's wish to use it in another way, an act in which not one of his colleagues duplicated him. [Thus, Hall, who never used the name, said of it in 1843 (page 144): "The name of Catskill Shaly Limestone, which has been proposed on account of its great development on the Catskill Creek, is found to be objectionable, as it at once carries the mind to the Catskill Mountains, a very different group of rocks, thus tending to propagate a false impression."] But the name "Catskill shaly" was taken up in this sense by David Dale Owen (1846) and adopted by Dana in his great Manual down to the latest edition and in his and various textbooks, as well as by S. A. Miller in 1889 (page 56) and in some reports of the other states (as Hopkins' Arkansas), so that it can not be said to lack standing. Lincklaen used it in 1861 (page 58 and plate IX) and also in the form "Catskill limestone;" and Merrill in 1898 (page 157) copies him. "Catskill shaly limestone" is mentioned repeatedly by John Mason Clarke, of the New York State Museum, as late as 1899, in State Museum Handbook 15 (pages 16, 22, 26, 30, 32, 34, 45).

The "CATSKILL GROUP" is described by Vanuxem on pages 186 to 194 of this same 1842 final report, although for the only statements about it that concern us we must turn back to his page 16: "*Catskill Group*. This is the terminal member of the New-York

system, founded upon an important geographical character. . . . It is the uninterrupted extension west of the Catskill mountain range, which diminishes in height and thickness entering the district." The last clause refers to the rock, not the mountains, for these do not cross the Susquehanna river into Vanuxem's third district. The name reappears several times also in the county accounts. All told, it covers in this report beds of Oneonta, Katsberg, Catawissa and Montrose ages, thus nearly spanning the Senecan.

The beds at "Post's Mills" to which Mather had previously applied the name "Catskill" in the account and section above quoted are not comprised at all in Vanuxem's Catskill group, for in Vanuxem's district the equivalent beds are marine Hamilton. But if we do not accept "Catskill series" of Mather 1841 as the first publication, since it may have been a slip of the pen or the typesetter, then it becomes a serious problem whether "Catskill shaly limestone" of Vanuxem 1842 does not have precedence (by one page) over "Catskill group" of the same report. It is only by neglecting the employment of these two names in the tables of contents and of formations, where indeed they are sufficiently defined by the synonymy, and considering the brief statement on page 16 to define the "Catskill group" in advance of the longer accounts of the limestone on page 120 and the group on page 186, that we can assure the name Catskill to the Upper Devonian red-beds rather than to the Lower Devonian limestone, if we credit it to Vanuxem.

There is, however, of course another consideration not to be overlooked, namely that the accidents of publication whereby Vanuxem's more slender volume came off the press in the calendar year preceding Mather's more bulky one should not deprive Mather of the right to father his own child, to define his own group, or division as he preferred to rank it. For Vanuxem, it was only an adopted name.

This final report on the first district by Mather in 1843, after including the "Catskill division" in the table of contents (pages xxvii, xxviii) and list of formations (page 2), as the highest or fifth division of the New York system, as had Vanuxem, proceeds on pages 299 to 316 to describe it as follows:

"I. CATSKILL DIVISION. Upper members of the Catskill mountain series of the Geological Reports for 1840 and 1841. Montrose sandstone, and Oneonta sandstone of Geological Reports of New-York. Old red sandstone, probably, of Europe. Nos. 9, 10, 11 and 12, of the Pennsylvania Geological Reports. Old red sandstone, No. 9 Mr. Conrad's arrangement.

"The Catskill division of rocks consists of coarse and fine grits, with various shades of red, brown, grey, greenish, and mottled red and green, which lie thick bedded with the oblique laminae of deposition strongly marked . . . ; conglomerates of various degrees of coarseness, greyish, greenish and red; slaty fissile sandstones, with slates and shales of various colors, as red, green, and mottled with these colors, grey and black. Testaceous fossils are extremely rare. Terrene and marine plants are more common." [This account of the Catskill rocks should be compared with that of Mather in 1840, given on a previous page.] Then, skipping two pages of illustrations, he continues (page 302):

"The impressions of fucoids are very common on some of the red rocks, of both shales and sandstones.

"No bones or scales of fish have been observed in these rocks, in the First geological district.

"The general arrangement of the parts of the Catskill division is,

1. Conglomerates, and coarse grits.
2. Red shales, slates and grits.
3. Grey and greenish grey slaty grits.
4. Chocolate-colored grits, with red shales and slates."

This, it will be observed, is but a rephrasing of the first four out of the six parts enumerated by Mather in 1840 for his Catskill Mountain series, and indicates, as does his synonymy, no change in the upward limits except, of course, his apparent slip in now listing "No. 12" or the present Pottsville conglomerate of the Pennsylvania survey. This is belied on the following page, but first comes (still on page 302) the following largely erroneous statement:

"The Montrose sandstone of Prof. Vanuxem is below the top of this series in the Catskill mountains; and beneath this, nearly all the strata described by him in his reports are found, characterized by their peculiar fossils; but these rocks in the First geological district are generally of a coarser texture . . . than in the Third district; and the fossils are as rare comparatively in this, as they are abundant and beautifully preserved in the other." (Mather is here practically reprinting the paragraph from his report of 1840, which has been quoted previously, and with which this should be compared. Furthermore, he is confusing the Schoharie valley section with that on the Catskill front.) It is not the Montrose sandstone, which does not get across the Delaware river into New York (see figure 3), but the Oneonta sandstone that Vanuxem thought identical, which is present in the Catskills, as already explained. Then comes:

"The Catskill division occupies the county of Delaware, and portions of the counties of Sullivan, Ulster, Greene, Schoharie and Albany. . . . These strata are all below the coal-bearing rocks of Pennsylvania, . . .

"By referring to the Geological map of the State, it will be seen that the Catskill division occupies a small area in the Third and Fourth geological districts, along the southern boundary of the State, but the main body of it forms the elevated land called the Catskill mountains." This is the sole time, and by implication only, that the name "Catskill" is extended over the (post-Chemung) reds of western New York (fourth district) in these annual or final reports. Not only was Mather thus reaching out far beyond the territory personally explored by him, but the map itself (the second edition, of 1844, is at hand) does not use this name; its legend reads: "P. Catskill Mt. Rocks, or Red Sandstone" (not Old Red), while for the sections cutting these post-Chemung reds the only label given is still simply "Old Red Sandstone," although in the sections of the Catskills both names are given. Nor does the map color for these "Catskill Mt. Rocks" extend beyond the third district; the small outlined patches farther west, inclosing outcrops of conglomerate, are overspread with the general Chemung color.

A very important, and disturbing, detail now follows. On pages (302) 303 to 305, Mather reprints his long section from the top of South mountain to the "Caterskill creek" (misprinted "Catskill creek" on page 303 as in 1841) which has been quoted in full above, but (the strata are renumbered from the summit, so as to increase by 10 all numbers from the Table Rock down) with these significant differences: (a) the terraces below "Terrace No. 3." (stratum 125, former 115) are assigned to the "ERIE DIVISION," down to include the Marcellus shales (133), thus defining his lower limit of the Catskill at the base of the red-beds, as locally developed; (b) the upper limit of the "CATSKILL DIVISION" is explicitly put at 87 feet above the Mountain House ledge [or at 2,317 feet above sea], on South mountain, while the overlying beds of conglomerate and grit are headed "LOWER GRITS OF THE COAL FORMATION." On page 295, preceding, Mather states: "The coal formation can scarcely be said to be found in the First Geological District, or even within the State of New-York. The lowest beds only, the conglomerate and coarse grits underlying the coal beds, and forming the base of the coal formation, are found in small patches as outliers, on the summits of some of the high peaks of the Catskill mountains."

This would seem to imply that Mather assigned these puddingstone ledges to the Pottsville conglomerate (and separated them from the Catskill?), in curious contrast to his inclusion of the Pottsville (No. 12) in his synonyms of the Catskill division, on page 299, quoted. In as much as one can put his hand today on the exact layers of Mather's measured section above the Mountain House, and as the heavy puddingstone or "third ledge" (Walton Van Loan's map) is of the age of the Sherburne sandstones (Genesee group) at the base of the Senecan, Mather's precisely limited type section of his "Catskill division" becomes Hamilton in age (including Tully) and essentially equivalent to the Kiskatom red-beds of Chadwick (1932), which agrees with Mather's first use of "Catskill" at Post's mills.

This section at Post's mills is likewise reprinted (page 305) following the other, with this introductory remark: "Numerous fine sections were observed in the various ravines in the Catskill mountains, some localities of which will presently be mentioned; but the preceding and subjoined sections shew the general arrangement of the strata of the Catskill division." The 48 localities enumerated on pages 307 to 312 cover strata ranging from the Kiskatom up into the lower Chemung (Catawissa red-beds; seventeen of these (namely 1, 6, 8, 18, 20 to 32) are in the Kiskatom, three (7, 9, 11) in the Kiskatom and Onteora, two (10, 33) in Kiskatom to Stony Clove flagstones, and one (12) in Kiskatom to Katsberg; of the remainder, ten are in the Onteora (2 to 5, 15, 19, 34, 37, 43, 44), two (38, 42) in the Onteora and Kattel or Stony Clove, five (13, 36, 39, 41, 45) in Onteora and Katsberg, three (14, 16, 17) in Onteora to Catawissa, one (35) in the Kattel and Katsberg, two (40, 48) in the Katsberg proper, and two (46, 47) in Katsberg and Catawissa; thus only five reach up into the Chemung (Catawissa), while over a third are confined to the Hamilton (Kiskatom) as in the type section.

A dilemma is thus presented. Shall Mather's "Catskill" be limited to the Middle Devonian (Kiskatom) of his precisely itemized "type section" up the old Mountain Road, the exact location of which is still known (see figures 5 and 6), as explained in an earlier page? Or shall his inclusive statements and his long list of localities prevail in our estimation over his erroneous identification of the Sherburne conglomerates with the "lower grits of the coal formation" so that his "Catskill division" shall be understood to embrace also all the overlying Senecan (Upper Devonian) as seems to have been his intention? In the former event, his "Catskill" and Vanuxem's are two distinct things, the one Erian, the other Senecan. In the latter solution, Mather's "Catskill" is larger than and contains Vanuxem's.

It should be taken into consideration that Mather's recognition of "coal formation" rocks on the Catskills came very suddenly at the end, as his volume went to press. It was a view not concurred in by the other members of the survey. It finds no expression on the geological map put out by these four men, including Mather, as that has no place nor legend for Paleozoic rocks higher than Old Red Sandstone. In the plates and sections, even, accompanying Mather's report, there is no recognition of such "coal" rocks; he stated in 1841 (see quotation given) that the highest strata in New York, below the "drift and tertiary," fall short of the base of the coal formation. Moreover, right up to the last (page 302) he keeps the "I. Conglomerates, and coarse grits," still in his list of members of the "Catskill."

SUBSEQUENT HISTORY OF "CATSKILL"

The subsequent history of the name Catskill, thus established in the literature, is intricate even when considered only with reference to the Catskill Mountain region. Its rapid but unwarranted extension outside that region over later red-beds that have no equivalents in the Catskills and belong to distinct geologic epochs has of course no bearing on the determination of the value and scope of the name, however much that name may have wrongly taken hold in those other areas for Chautauquan, Bradfordian and even Waverlian reds. But usage and restriction within the type area do count in the final adjudication.

Overlying strata. In passing, we may note, however, that Mather's belated idea of post-Devonic age for the higher rocks in our mountains was curiously persistent in a modified form among outside geologists, especially those of Pennsylvania, and that it appealed at times even to the members of the New York survey. Thus we have Joseph Peter Lesley, the state geologist of Pennsylvania, saying in 1875 (page 52): "the . . . No. X (Vespertine) . . . , outlying patches of which, 500 to 1,000 feet thick, form the higher knobs of the Catskill Mountain, . . ." at the same time calling this Vespertine also frequently (pages 98, 100, 104, 105) by the alternative name "Upper White Catskill," which seems to have had wide currency at that time. Again, in 1878, Lesley says (page 15): "the Catskill Mountain on the Hudson shows side walls of Red Catskill rocks, supporting peaks of the White Catskill rocks, 4,000 feet high." In the index, however, the name "Pocono" replaces "Vespertine" or "White Catskill." In 1878, Charles Albert Ashburner*

* See Note at end of this Bulletin.

(pages 218 to 219) included the uppermost 1385 feet (through an error in addition made to appear as 1412 feet) of Sherwood's Roundtop mountain section in the "Gray beds, X," meaning thereby the Vespertine. In 1880, Henry Martyn Chance of the Pennsylvania survey says (page 107): "The numerous peaks of the Catskill mountains are patches of Pocono sandstone, No. X, which have escaped the general erosion of the country. These rise a thousand feet above the Catskill plateau. . . . But the transition from Catskill to Pocono in that region has not been studied." Once more, in 1882, Lesley reiterates (page x) concerning our mountains: "The peaks are what remain of the overlying grey Subcarboniferous, Pocono formation (No. X,) which formerly spread continuously over the red Catskill." Lesley's assistant, Ashburner, published in 1888 (page 954) a tabular section that he had measured "from the top of the Catskill mountains to the bottom of the Mohawk valley" in which he assigns 1000 feet thickness to the "No. X. Pocono or White Catskill sandstone and conglomerate," and 2900 feet to the "No. IX. Catskill red sandstone and shale." Finally, in his Summary Report of 1892 (page 1567), Lesley still asserts of the Catskill plateau that "it is a lofty table-land . . . supporting remnants of still higher grey sandstone deposits, constituting isolated peaks, some of which reach heights of 4500 feet above tide. These were once called the Upper Gray Catskill rocks, but are now named in the Reports of the Pennsylvania Survey Pocono No. X." And further that they are "preserved to the extent of only about 1000 feet in these New York peaks, . . . Moreover, with this Pocono gray sandstone formation begins the Carboniferous System." Correspondingly, Ashburner's map, in the paper above mentioned, covers the Catskills with extensive patches of "Carboniferous", (including in one color the Pocono, Mauch Chunk, Pottsville and Coal Measures).

This is not altogether the same as Mather's belief, which apparently was that these peaks belonged to the Pottsville conglomerate ("No. XII"), higher than the Pocono, this being the interpretation put upon his wording by Lesley in 1882 (footnote to page x); and it is to be noted, moreover, that while Dana's Manual of Geology of 1874 (page 375) was already putting the "Vespertine" in the "Subcarboniferous" yet these Pennsylvania reports (as well as Samuel Almond Miller, 1877, page 15) did not definitely remove it from its Devonian associations until after 1878. But meantime the influence of the Pennsylvania men was felt more directly, in that the brothers Andrew and Clark Sherwood were brought from that state into New York

by James Hall, our State Geologist, for four years (from 1871 to 1874) of mapping and measuring in the Catskills. In 1875, Hall exhibited a map (never published, except as it probably served as the basis of Ashburner's map above mentioned) comprising the results of their work, of which he said (1876, page 81) that it "has not only accomplished what was undertaken, but has proved conclusively, the existence (first suspected in 1857) of higher formations, lying upon the red Catskill rocks. . . . The expression of the map, in its coloring, shows the direction and extent of certain belts of red rock, which in some part of their extent are crowned by gray sandstone and conglomerate, referred to the Vespertine and Umbral [Mauch Chunk] formations of Professor Rogers, and are regarded as belonging to the Carboniferous age." And on page 82: "The synclinals everywhere present high and broken ridges, and more especially so when the Vespertine and Umbral rocks form the terminal mass." On page 83: ". . . the higher beds, of Vespertine, extending to the summit of [Kaaterskill] Round-Top, may be reckoned at about eight hundred feet. The passage from the red rocks to the Gray Sandstone and Conglomerate is gradual, with alternations of red and gray rocks, and does not afford any strong line of demarkation." It is necessary to anticipate by explaining that both the structures and the strata depicted by the Sherwoods did not stand review and vanished from later maps. There is also a matter of curiosity here concerning Hall's specific statement in 1880 (page 290) that "In this work [of 1875] upon the structural character, in regard to the anticlinal and synclinal arrangement of the strata, the question of a subdivision of the formation has not been presented, . . ."

Turning back to Hall's "first suspicions," in 1859 (page 51) he remarks on the Catskill group "raising its summit (including the conglomerate) in the Catskill mountains to the height of 3800 feet above tide water," the conglomerate "forming heavy masses at the summit of the formation." In the following page he states that, southward, there is, "succeeding to the coarse conglomerate of the summit of the Catskill mountains, a formation of red shale . . . which . . . attains a thickness of three thousand feet [Umbral or Mauch Chunk, as shown by the thickness given], and is succeeded by the [Pottsville] conglomerate of the Coal measures. . . ." In all of this, as in 1883 when he said (page 65): "the Catskill, including the upper member or Pocono sandstone," Hall seems still to include the conglomerate within the Catskill formation. But on page 53 (in 1859) he gives a table in which are listed, downwards, "Coal measures, Red shales, Conglomerate, Catskill-mountain group,"

and the last three are all referred to the "Great Carboniferous limestone of the Mississippi valley." That he then had no real intention, however, of sundering the conglomerate from the Catskill is indicated by his saying lower on this same page: "the Catskill-mountain group (Formations IX and X of the Pennsylvania Survey), . . ." (Number X is the present Pocono.)

But it was so separated by Lincklaen, in 1861, who says (page 70): "Above these 'Catskill mountain strata,' lies the rock which is considered as the base of the great CARBONIFEROUS SYSTEM of Pennsylvania. It is mainly a mass of hard CONGLOMERATE. . . ." He continues (page 71): "This conglomerate rock is found on the summits of the Catskills," and: "It is possible that a few strata of [still] later origin, belonging to the Carboniferous formation, may exist on the Catskill summits." In his illustrative localities (Olean, Ellicottville, Wellsville), Lincklaen confuses the Pottsville, Salamanca and Hinsdale conglomerates, but, as he says it is succeeded by the "Umbral red shale" [Mauch Chunk], he clearly means the Pocono. In the following year (1862), however, Hall proposed (page 381) "to restrict the term *Cattskill group* to the beds . . . formerly known as X [Pocono] and XI [Mauch Chunk] of the Pennsylvania Survey," namely to the very beds that the others had separated from the Catskill and made "Carboniferous," because he thought the Blossburg reds to be "XI" without any "conglomerate, No. 10" below them.

Nevertheless, in 1878 Hall reverses himself and (page 215) declares that the tops "of Round Top, High Peak, and other summits" are composed of "the coarse sandstones and conglomerates of lower carboniferous formations—the vespertine and umbral . . ." and in 1879 (page 15) Hall states that "at least the upper 900 feet of the Catskill mountains consist of . . . No. X, . . . Vespertine."

There is an echo of Lincklaen in Merrill, 1898 (page 166) and a recrudescence of this notion in 1903, when John M. Clarke, in arguing for the "Carbonic" age of the Cattaraugus beds near Olean, said (page 998): "I feel that we should be specially cautious in taking for proven that Catskill sedimentation even in the typical section of the Catskill mountains is restricted to Devonian time. . . . It is not a new suggestion that the upper stages of the typical Catskill are postdevonian; . . ." In the same year, in his handbook of New York rocks (page 42), Clarke says that the "Catskill beds are . . . contemporaneous . . . perhaps in . . . later stages with postdevonian sediments of Allegany and Cattaraugus

counties," which, in his table 2 (opposite page 26), he puts into the "Carbonic;" and he dwells on these same fancies again in 1904 (pages 208 and 209). The last reverberation* of this is in Chris Andrew Hartnagel's revised edition of this handbook, in 1912 (page 86): "Farther to the south and west the Catskill type of sedimentation began later and is contemporaneous with the Chemung deposits, and perhaps in its later stages, as developed in the Catskills, with the Postdevonic sediments in Allegany and Cattaraugus counties."

Realization that, unlike the truly Mississippian "Vespertine" rocks farther southwest that have also been believed to be "Pocono," the strata of the Pocono mountains and Pocono plateau are none of them later in age than Chemung (Senecan), and therefore but little later than anything in the Catskills, makes all this seem a fuss about nothing; yet, lest it should exert a prescriptive effect on the definition of the name "Catskill," it will be well to examine it further.

Upper limit. Following Mather's sudden change of opinion in 1843, the next writer is Professor Ebenezer Emmons in his report on the soils and rocks of New York (1846, volume 1). In his preliminary statement (page 116), Emmons follows the other final reports in carrying the Erie division up to include the Portage and Chemung groups (and in following this with the "Catskill division"), saying: "This upper division, which is intended to extend to the Catskill or Old Red Sandstone . . . embraces without doubt the Devonian system of Phillips; . . ." And further, under "The Catskill division, or the Old Red system:": "Beds of conglomerate also abound in different parts of the mass, but more conspicuously towards the top of the Catskill mountains." But on taking up these rocks in detail he institutes an innovation, stops the Erie division with the Tully limestone and includes in the Catskill division everything from the Genesee shale up, saying (page 188) that "it forms by itself a distinct system, and has been described by Mr. Phillips under the name of Devonian system . . . to embrace . . . the Old Red sandstone." While this acute and novel step is of chief interest in determining what shall be taken for the lower limits of the Catskill, it is of more immediate importance that, on account of the "diagonal stratification" (page 193), "the upper part of the Chemung group . . . might, with great propriety, be referred to the Catskill division." Since he has just referred the whole of the Chemung, as well as the Portage and Genesee, to this Catskill division, the only interpretation of this is that Emmons already sensed the equivalence of Chemung and Catskill that was proclaimed long afterward by Hall and others, that is, that a lateral gradation of facies

* See Note at end of this Bulletin.

occurs in these Upper Devonian beds. As for the upper limit, Emmons follows the Catskill with the Triassic "New Red sandstone," without place or mention of any Carboniferous rocks within the entire State, colors the entire Catskill Mountain region with the single Catskill color on both his map (of 1844, previously described) and his plates; these plates include (plate VII facing page 214) a large panorama of the "Cattskill Range" from opposite Catskill, and (plate I facing page 153) another of the "Helderberg Range" from opposite Albany, with the Catskills (Black Dome, etc.) in the background, of which he says (page 363): "The lowest rocks belong to the Champlain division, the upper to the Catskill." These leave no possible doubt that he intended to have the Catskill division or group include all strata to the summits of the Catskills. Yet on page 195 he concedes: "The conglomerates and coarse grits above the Catskill Mountain House, have been referred to the Coal series, and this is probably right." It is to be noted that this hotel stands on the front range, in plain view from Catskill, and over 1700 feet lower than Blackhead and other peaks shown in his plate VII; hence the coloring of that plate directly contradicts this concession to Mather. Nevertheless, in describing section 3 of Plate XXI (at end of volume) "from Cattskill to Gilboa," he once more says (page 367): "The superior mass of the Catskill mountains is undoubtedly the conglomerate of the Carboniferous series or system: it is colored purple." [In my copy, the section is uncolored, and the name "Old Red Sandstone" seems to denote these summit rocks.] The former part of the description, above, reads: "The turnpike route from Catskill to Gilboa exhibits the great scale upon which the Catskill division is developed in New York."

Mather's upward limitation in 1843, a little above the Mountain House, is, as before stated, at (approximately, at least) the base of the Sherburne, or Genesee, and would make his restricted Catskill to be of Hamilton age (Kiskatom) excluding all the Upper Devonian, or Senecan, portion. This, curiously, is just the point where Hall in 1863 (page 108) would put the bottom instead of the top of the Catskill, saying that that name "is not at all applicable . . . below the elevation of the Mountain House." And, although later on (1879, page 14) Hall claimed to have recognized in 1857 the post-Catskill (that is, post-Blossburg) age of the higher strata on the south "(and to some extent on the north . . .)" of the Kaaterskill Clove, it was not until 1876 that he suggested in print (page 81) any other upward limitation than that of Mather in 1840 (the top of the Senecan). After the decade of Pennsylvania influence, above

described, Hall returned in 1885 to the former upward extension of the Catskill group, from which he and other New York workers seem never afterward to have receded.

But the upper limits of the Catskill (or "red Catskill") set by the Sherwoods, Lesley and Ashburner are many hundreds of feet above where Mather put his limit, at the Mountain House "third ledge." Besides, they will differ greatly in stratigraphic position on different peaks. The strong southwest dip which these workers mention but of whose effect they fail to take proper account means that, on Slide mountain (Ashburner's section of 1888), a thousand feet down is barely to the top of the Wittenberg conglomerate of middle Enfield age, whereas on Wittenberg itself, only four miles away, it would be below the base of that conglomerate and still farther below it on Hunter mountain, 13 miles northeast; 8 miles east, on Kaaterskill High Peak and Roundtop, southwest of the Mountain House, (Sherwood's section of 1878), as well as on Black Dome, 7 or 8 miles north of these, a thousand feet down would be well down in the Oneonta strata below the Stony Clove sandstones of the basal Enfield, but still five or six hundred feet higher stratigraphically than the third ledge at the Mountain House, or, if Hall's figure of eight hundred feet on Roundtop be taken, the line is two hundred feet higher in the Oneonta; but on North mountain, just north of the hotel, a thousand feet brings it down to near the Oneonta base on Stoppel peak, and to just about the Sherburne base on the nearer peak, thus corresponding to Mather's line on the companion or South mountain; on Overlook, eight miles south on the plateau front, 1,000 feet would be down several hundred feet into the upper Kiskatom. This misunderstanding was corrected by Darton in 1894 (page 362) as quoted beyond.

The phenomenon of the conglomerates appearing at lower and lower levels in the geologic column towards the east has misled all these observers. Consequently, since they do not specify (except Hall) a precise locality, the limit they attempt to set is far too elusive to hold any weight today. Only by occasional accident does it correspond with any real formational boundary line. Hence, unless we take Mather's 1843 definition, the upward limit of the Catskill formation in the Catskills must be the mountain summits, as Mather himself before 1843, and all the others, took it to be. To this statement we may except only the Slide Mountain conglomerate, should the later history warrant, although territorially Mather's Catskill involved still higher (Catawissa) beds in western Delaware county. The latest geologic map of the State (Merrill's in 1901) shows only

"Catskill," and nothing higher, across the whole Catskill plateau to Broome county, and for some distance into Pennsylvania, beyond the Delaware river. Professor H. S. Williams in 1887 (page 20) still carried the Catskill up to the Pottsville in this region.

Thus, barring Mather's second thought, the Catskill may safely be taken to include at least all the Senecan red-beds of the Catskill mountain area as far as the Delaware river and the Susquehanna to where these leave New York. It is certain that its upper limit must rest upon its delimitation and usage in the type area and not upon subsequent misidentifications of it elsewhere. Such extra-limital use can in no way compromise its true value or content.

Underlying strata. Concerning the lower boundary of the Catskill formation, the story is even more devious. There are two distinct items in dispute; first, as to what rocks directly underlie it; second, as to just where, within the red-beds themselves and in the type section, the line shall be drawn. The latter alone is of real significance, but the former has so affected general reasoning and the wider applications of the name that it must be reviewed. Reference has already been made above (page 23) to the doubt whether Conrad (1839) intended to put the Old Red Sandstone above the Chemung, or to make the Senecan, and perhaps even the Erian, equivalent to the Old Red; but there is no doubt both that Hall in 1859 (page 34, table) put the still much lower beds of the "Upper Helderberg" [Onondaga limestone] into the "Old Red sandstone," and that Hall's Old Red [Blossburg] of 1840 and 1843 (see pages 23 and 24) is above and rests upon the Chemung, as Hall himself knew it does.

Because of the latter fact, Vanuxem (1842, pages 12, 13, 186) was led to make his "Catskill group" (or division) follow upon the Chemung, seemingly at Hall's insistence and partly because he was confusing with the Montrose sandstone, which has a part (Cayuta beds) of the fossiliferous Chemung beneath it, the Oneonta sandstone much lower, which has a pre-nuncial Ithaca fauna (Sherburne and, farther west, Otselic) beneath it. But, in his chapter (VI) on "Localities of Superposition," Vanuxem says (page 202): "The Ithaca, Chemung and Catskill groups, having no precise lines of division between them, cannot so well be illustrated by such small engravings, and are therefore not given." In this connection it must not be forgotten, however, that (on page 192), in speaking of Oneonta, the type locality, Vanuxem also said: "These [Oneonta] rocks occupy the highest part of the face of the hill, the base of

which is composed of rocks which I have supposed to belong to the Ithaca group," an order of superposition which has been confirmed by many subsequent workers, including Professor Charles Smith Prosser (1893, pages 226 to 228) and the writer; and further, that Hall persuaded Vanuxem into his own notion that the Ithaca rocks were Chemung, as explained by Vanuxem on page 171 of the same final report, (compare Hall, 1843, page 250). Thus it can hardly be maintained that Vanuxem himself really bottomed his Catskill on the Chemung, since he makes the Oneonta an integral part of it.

Emmons (final report, 1842), whose territory was the Adirondacks, although credited by S. A. Miller (1889) with authorship of the name "Catskill," had naught to do with these higher formations, and gives the complete classification for the State only as a closing page of his report (page 429), saying: "Old Red System, Old Red sandstone, with its beds of conglomerate, and its greenish shales of the Catskill mountains," following after the "Chemung shales and grits" of the "Erie Group." It is plain that this has no evidential value. As for Hall, we have already seen (pages 23 and 24) that he side-stepped the name "Catskill" and used only "Old Red," so that it is only by later confusion that he can be invoked as to the post-Chemung position of the Catskill. This is recurred to beyond.

Mather (1843) seems to have had a clearer idea of the facts. Beneath the Catskill he has (page 2) the Erie division, but in his "synonims" for the latter (on page 317) he enumerates only members of the Hamilton group, and farther down this page, although he says that westward the Erie includes "1. Ithaca and Chemung" above the Hamilton, he adds these incisive words: "The Portage group, Genesee shales and Tully limestone, of the Erie division, if they exist in the First district, have not been recognized as such." Nor does he describe the Ithaca and Chemung as present. It would appear, at least by inference, that Mather believed the Catskill in this his (the type) area to repose upon the Hamilton rocks, as it actually does. In fact, Hall, who had known Mather personally, specifically says in 1873 (page 7) that "the coming in of red rock in the formation above the Hamilton group, had induced Mr. Mather to recognize the great accumulation of strata forming the Catskill Mountains, as the 'Catskill group'."

The remarkable and prophetic decision of Emmons, in 1846, to include within the Catskill division everything above the Tully limestone has already been noticed (page 37). It was with rare perception that Emmons selected for the base of his Catskill the

line that we now take for the Upper Devonian datum; and it must have been his feeling, like Mather's, that the eastern or type Catskill follows directly upon the Hamilton. Yet, in those days of groping, Emmons is as inconsistent about the lower as about the upper limit, which is not surprising considering how fast the lowest red layers descend in the time scale toward the east. For (pages 195 and 196), after describing the section of the Manorkill falls at Gilboa, rocks now known to belong to the upper Hamilton Moscow member, as an example of the Catskill beds, and as containing the shell now called *Archanodon* (or *Amnigenia*) *catskillensis* of the Oneonta beds, he goes on to report the discovery of supposed Chemung fossils still above these, "at the base of the Catskill series." His observations, while somewhat confused and obscure in the wording, are nevertheless worth quoting rather fully, and will be better understood if it is remembered that to Emmons the Devonian meant the Old Red or nonmarine (continental) strata bearing fishes, plants and freshwater clams, only.

He says: "An interesting locality of the Catskill division exists at Gilboa. A good section is exposed by the Manorkill, a creek which flows from the east, and falls into the Schoharie creek near the village." The section then follows, and: "Above the Manorkill falls, the red marl or slate is many feet thick. This is succeeded by the greenish and coarse sandstone shales alternating for five or six hundred feet, and appearing in high and steep escarpments on the mountain [Stevens Mountain] half a mile north of the kill: the rock contains a few *Cypricardia* [*Archanodon*]. The whole series is fossiliferous; more so, we think, than what appears upon a cursory examination, . . . Now the stratum which contains vegetables at other places, contains also *Cypricardia*. . . . the stratum itself . . . is the same as that described in Mr. Vanuxem's report, . . . at Mount Upton on the Unadilla. The discovery of this stratum . . . at Gilboa . . . identifies two distant series, . . ." and, in Emmons opinion, makes the Gilboa rocks of Oneonta age, as at Mount Upton. He continues:

"The coarse grits continue to Prattsville; and though often concealed by debris along the banks of the Schoharie creek, yet a glance at the cliffs of the adjacent hills will . . . settle the fact that the strata of Gilboa continue uninterruptedly to Prattsville; and as but little progress is made towards the south, or in the direction of the dip, we may feel satisfied that we gain but little in height. This is important to be borne in mind, for it has been said [by whom?] that the rocks of Gilboa belong to the Hamilton group, and

as fossils closely resembling those of this formation were discovered six or seven hundred feet at least above the locality on the Manorkill, where [here we turn the page to 196] Devonian [i. e., Old Red] fossils had been found, it became important to accumulate as many facts as possible . . . ; and we were fortunate enough to discover the remains of fish in the strata between Prattsville and Gilboa, and, what was still more satisfactory was their association with the *Cypricardia catskillensis*. . . ."

Jumping ten miles northwest to Jefferson, where, he says, the rocks are the same, he finds there "the same fossils as those of Gilboa, namely, the *Cypricardia*, *Tentaculites*, *Orthis*, etc." (forms not before mentioned), besides that "Mr. Hall has discovered a scale of the fish characteristic of the Old Red sandstone. In these discoveries we have the facts which have settled the character and age of the rocks in the southern part of Schoharie, Albany, and those of Greene and Delaware counties. They form one series of rocks, . . . ; and as a few fossils of the Chemung narrows have been found in Gilboa, we are able to connect the series with distant points west. The Chemung group, which had been supposed to be confined to the southwestern counties, has been proved, by the discovery of fossils, to occupy a place also at the base of the Catskill series. Of the *Dipleura dekayi*, *Microdon bellistriata*, *Cypricardia angulata*, the latter is credited to Chemung narrows, while the two former are well known Hamilton fossils; these, with several others, occur five hundred feet above strata which have hitherto been regarded as belonging exclusively to the Catskill series. Facts of this kind may lead us to distrust the value of our lines of demarkation between the groups of a system."

The interpenetration of marine and continental beds around Gilboa has been verified by both Prosser and the writer, while more recently all these fossiliferous layers (including also the famous tree-stumps) have been shown by Dr. Gustaf Arthur Cooper to belong to the Hamilton (inclusive of the Tully) as Hall had already announced in 1870, not to the Ithaca and Oneonta beds as claimed by Prosser in 1899. Before leaving Emmons, we may note one other statement he makes (page 116), namely: "The change from the *Marcellus* shales upward to the Catskill rocks, is so gradual and imperceptible, that the outgoing of the Silurian or New-York system, and the incoming of the Devonian, never can be settled by geologists, except by conventionally agreeing where the one shall stop and the other begin." In all this there is small comfort for those who would make the Catskill follow the Chemung—from his account it is clear that

his "at the base of the Catskill" means actually "in" the base and for several hundred feet up in it; in short, the time equivalent of at least a part of it.

With Mather, Vanuxem and Emmons all reluctant to put the Catskill above the Chemung, or the Chemung below the Catskill, it is Hall and Dana who become responsible for performing this trick. Hall's influence on Vanuxem has already been mentioned. In 1859, Hall said (page 51): "Following the Chemung group, we have in New-York the shales and sandstones of the Catskill mountains, . . ." to which he presently alludes (page 52) as "the Catskill mountain group" or simply "the Catskill group," [and then (page 53) assigns to "the great Carboniferous limestone series"]. Lincklaen also, in 1861 (page 70), said: "The Chemung group passes or changes upward into the Catskill," [which Merrill paraphrased in 1898 (page 165) as "passes or changes eastward," showing how men's ideas had changed meantime]. In 1863, the very year in which Hall first announced that Catskill rocks are of Chemung age, Professor James Dwight Dana took up this assignment of Catskill to a place above the Chemung, in his new *Manual of Geology*, and gave it currency in successive editions (and also of his *Text Book*) of 1875 and 1880, abandoning it only in 1895. Meantime the outside geologists finding Catskill a very useful name for the red-beds of post-Catskill age that occur from Bradford county westward in Pennsylvania, lying over beds carrying the Chemung (and higher supposed Chemung) marine faunas, warmly espoused this perversion of the term, to supplant No. IX, Ponent or Old Red sandstone of the Pennsylvania survey (see Lesley, 1883), and assiduously tried to steal it away from its home locality and true connotation. They have almost convinced the world that the type section of the "true" Catskill is at Altoona, in central Pennsylvania!

Lower limit. Henceforward the two problems, of what is below the Catskill and where the basal line of the latter shall be drawn, become so involved that they must be discussed together. In 1862 and 1863 (page 107), Hall saw new light, not unlike that which had dawned upon Emmons 16 years earlier and been ignored by Hall, thus: "I am satisfied that the beds in the eastern part of the State of New-York, which have been referred to the Catskill group, are in reality, to a great extent, of the Chemung group [in 1862 (page 377) Hall said "Portage and Chemung"]; that the coarser character of materials in the upper part of the Hamilton group has, in many localities, so simulated the lithological character of the Chemung as

to be mistaken for the latter; and I am now disposed to believe that some isolated localities of the upper part of the Hamilton group have been referred to the Catskill group." But, still clinging to his notion that true Catskill must perforce be post-Chemung, and taking the Kattel shales of lower Enfield age above the Oneonta for Chemung beds, Hall continues: "These erroneous references have arisen, as I have said, partly from the coarseness of the upper part of the Hamilton group, and partly from the occurrence of an extensive deposit of red shaly sandstone and shale [Oneonta] at the base of the Chemung group, with alternations of similar beds at intervals in that group. At the same time the fossiliferous beds [Kattel] of the Chemung group are fewer, and the number of their species is far less than in the central and western part of the State. These conditions combined, have caused the Catskill group to be carried downwards from one thousand to fifteen hundred feet below beds which clearly belong to the Chemung group."

Hall's words were evoked by the discoveries made at Franklin, near Oneonta, by J. M. Way, a local enthusiast, of the fossiliferous Kattel shales overlying the red Oneonta rocks, and investigated and reported on to Hall in 1862 by Colonel Ezekiel Jewett, curator of the State Cabinet, to which report reference will be made hereafter. Jewett's visit was followed shortly by one from Hall himself (1862, page 378), who measured "A section from the north side of the Susquehanna river to the high hills in the south part of Franklin." This section since it is not in many libraries, is worth reprinting in full, though "the thicknesses given may be regarded as approximate." It is as follows:

"1.—Greenish-gray sandstones and shaly sandstones; 100–150 feet to top of hills. [Continued on page 379.]

"2.—Fossiliferous band with scales, bones, and teeth of fishes; *Aviculo pecten?* and a few Brachiopoda. (Remains of plants occur a little above the animal remains.)

"3.—Greenish and gray sandstones, shaly sandstones and shales; about 150 feet.

"4.—Fossiliferous band, containing bones and teeth of fishes; Brachiopoda and Lamellibranchiata, among which *Spirifer mesotrialis*, Hall, is abundant, and *Cypricardites* [*Goniophora*] *chemungensis* of Vanuxem is common.

"5.—Sandstones and shaly sandstones, similar to those above, but less greenish, and sometimes more heavily bedded; between 100 and 150 feet.

"6.—A fossiliferous band, similar to the one above, with the same species of fossils, and conspicuously marked by a compact argillo-calcareous band with carbonate of iron, and consisting largely of crinoidal remains in large fragments. Crinoidal bands of precisely similar character occur in the Chemung group in the central and western part of the State.

"7.—Non-fossiliferous shale and shaly sandstone, embracing flagstones and sandstones; about 100 feet.

"8.—Red shale and shaly sandstone, with numerous fucoidal remains; 400 to 500 feet.

"9.—Greenish and gray shales and shaly sandstones, with darker shales to the top of the Hamilton group; the thickness not well ascertained.

"10.—Hamilton group.

"Associated with these fossiliferous bands, and more conspicuously with the upper ones, we have bands of a peculiar greenish shaly [misprint for shale?] conglomerate or cornstone, which likewise contain fish remains. These cornstones, with their fossil remains, were noticed by Mr. Vanuxem in his report upon the adjacent country.

"There is a thickness of between 1,000 and 1,200 feet above the Hamilton group, the lower half of which is not yet known to be fossiliferous beyond the fucoïds in the red shaly sandstone.

"This red shaly sandstone and the dark and green shales below, together with the non-fossiliferous beds of No. 7 of the section, represent the Portage group; while the upper members are always marked by characteristic fossils of the Chemung group."

The localization of this section is better stated by Hall in 1880 (page 290): "In 1863 [1862?] I made a section across the formations from Schoharie to Oneonta and thence to Franklin and to the South-westward of that town, and across the country to Delhi in Delaware county, returning to Schoharie by a more Eastern route. The results proved unsatisfactory from the fact that crossing from Oneonta and approaching Franklin over red and mottled shales and sandstones with an apparent southwest dip, these were succeeded by gray and greenish shales and sandstones carrying Chemung fossils; and again, on the road to Delhi, these latter were succeeded by red rocks." He says further that the beds with Chemung fossils contain "some bones and teeth of fishes of a peculiar character," and that the overlying red-beds "in one locality in the town of Andes had already [before 1870] furnished scales of *Holoptychius*, and a nearly entire specimen of that fossil fish."

In this section, which Prosser, Darton and the writer have all revisited, numbers 1 to 7 are the Kattel beds, number 8 the Oneonta. From it, Hall says (page 377), was forced upon him "the conviction that the greater part of the area colored on the geological map of New York as *Cattskill group*, is in fact occupied by the Portage and Chemung groups." He adds (page 380): "I am inclined to believe that until we ascend the slopes of the Catskill mountains, and rise to an elevation of at least 2,000 feet above tide-water, we find no rocks of newer age than the Chemung group." Further (on page 380): "In looking back to the history of the adoption of the term *Cattskill group* it would appear that there was not entire unanimity as to its signification in some points, among the geologists of the 1st, 3rd, and 4th districts.

"Prof. Mather, in adopting the term, says it includes Nos. 9, 10, 11, and 12 of the Pennsylvania Survey; while Mr. Vanuxem restricts it to No. 9. As both these gentlemen placed it above the Chemung group as defined in central and western New York, I regarded it (without having made personal examination) as identical with a red shaly sandstone and conglomerate which clearly comes in above the Chemung in the adjacent counties of Pennsylvania bordering the 4th district. Having considered the Chemung as No. 9 of the Pennsylvania Survey, I regarded the red rock with *Holoptychus* as No. 11; the conglomerate, No. 10, [here begins page 381] not having been recognized in my district, or adjacent to its southern limits.

"I consider that at this time there can be no doubt that the Chemung group is identical with No. 9 in the original nomenclature of the Pennsylvania Survey; and the term Chemung group having been adopted, and well understood in its relations and signification, and well marked by its fossils, we cannot with any propriety continue to extend the term *Cattskill group* over a large area occupied by the older rocks, and well characterized by their contained fossils.

"Mr. Mather, in his descriptions of the rocks, has recognized the Chemung group as lying below the *Cattskill group*, but, as I have shown, the area colored by him as Chemung, is really Hamilton group; and it now becomes necessary to restrict the term *Cattskill group* to the beds above, or to those formerly known as X and XI of the Pennsylvania Survey."

Taken literally, this would shut the Catskill almost entirely out of New York, making it chiefly or entirely Montrose. But on turning again to 1863 it becomes clear that this is not Hall's understanding in the type section, for, while he still makes the Catskill supervene, confusing it evidently with his Old Red beds of his final report, he now asserts (page 108):

"The term 'Catskill group or Old Red Sandstone,' as applied in the central and western part of the State to some red beds occurring as outliers on the summits of the higher hills, and in a continuous formation beyond the limits of New-York in Pennsylvania, is not at all applicable to any beds in the Catskill mountains below the elevation of the Mountain House. It becomes, moreover, problematical whether anything more than the coarse conglomerates of the upper part of the Catskills can properly be designated Catskill group." This seems to be the first specific extension of the name "Catskill" to any beds above those of the Senecan; and it is only in the sense of being so "applied" that Hall finds it inappropriate for the beds below the Mountain House, the very ones to which Mather had tried to restrict his term. Had Hall known that his post-Chemung red-beds (Blossburg, and higher) get nowhere near the Catskills or their outskirts, what would then have been his final disposition of the name "Catskill"? Already he is trying to confine it to those higher coarse conglomerates that presently he and the entire Pennsylvania second survey are removing to the "Pocono" and considering post-Catskill. But this is the first attempt, in the Catskill front, or type section, to discriminate supposed Oneonta beds below from supposed true Catskill above. In 1879 he had, as we shall see, a wholly different idea. Meantime we must not fail to grasp that Hall is including "Portage" in his use of "Chemung," as evidenced by his further words (page 108): "The fossil plants . . . derived from places heretofore regarded as authentic localities of the Catskill group must all be referred to . . . the Hamilton and Chemung groups . . . and the species . . . will occupy but two stages, unless we recognize those of the Genesee slate as an intermediate group to the Hamilton and Chemung." (It was then common practice to include Genesee in Hamilton.) In this sense, the inclusion of the Oneonta "at" the "base of the Chemung" (a phrase recalling that of Emmons) is not erroneous. In 1868 (page 31), Hall refers the local "blue stone" [Ashokan] next under the red-beds [Kiskatom] to the (lower) Portage.

The bearing of Way's discovery, in Jewett's and Hall's announcements of it, seems to have been viewed at once in a different light by Professor Alexander Winchell (1863), as supporting (page 61) his "disbelief of its [the "Cattskill's"] existence as a distinct group, and serious doubts about the Devonian character of the Old Red Sandstone of New York," and "that it does not in reality overlie the Chemung;" removing thus "the only serious obstacle to the elevation of the New York Chemung . . . into the bounds of the

Carboniferous system." This may be interpreted either as the first expression of the idea of time equivalency of (type) Catskill with Chemung that later became universal, or else as putting the Catskill below the Chemung. But in 1871, Winchell went entirely back on this, regarding the Catskill of eastern New York as above the Chemung and intermediate between the Devonian and Carboniferous.

Influenced, perhaps, by Winchell, Hall in 1864 (page 307) changed his statement to "the conviction that the rocks named Catskill mountain group, by the New York geologists at the time of the survey, were really a part of the Chemung group," and that "more recently many fossils had been found, clearly identifying it with the Chemung group." "It had originally been defined *old red sandstone*," and it "still seemed probable that some portions of the higher peaks of the Catskill mountains were of this old red sandstone [that is, the post-Chemung Blossburg] formation." But in 1870 (page 565) Hall distinctly parallels (in a table) the "Catskill Mt. Sandstone" with the "Old Red Sandstone of Tioga [Blossburg], etc." and puts both back above the "Chemung Group."

Further explanation was made by Hall in 1870 (not printed until 1873), where he said (page 7): "We have long possessed evidence to show that the recognition of certain of the formations in some of the southern and south-eastern counties had been based upon incorrect or insufficient information. The almost total absence of fossils from the higher strata in the eastern part of the State, and the coming in of red rock in the formation above the Hamilton group, had induced Mr. Mather to recognize the great accumulation of strata forming the Catskill Mountains, as the 'Catskill group.' Mr. Vanuxem . . . yielded to Mr. Mather's views . . ., and the name 'Catskill' superseded the 'Montrose and Oneonta sandstone.' . . . In conformity with this view, the geological map has been made to represent a thinning of the Chemung group in the eastern part of the State, without any recognition of the existence of the Portage group in that region. This discrepancy between the nomenclature, as recognized in the central and western parts of the State, and that of the south-eastern counties, I had observed as early as the year 1844, while engaged in the collection of materials for the Paleontology of New York. [This is Hall's first allusion to 1844.]

"The adoption of Mr. Mather's views left little place for the Chemung group, and it was only by recognizing the higher [turning to page 8] arenaceous beds of the Hamilton as the Chemung, by the geologists of these adjacent districts, that such a disposition of the strata could be harmonized. At a later period, investigations in

strata, which are clearly above some of the red rocks, revealed the occurrence of characteristic fossils of the Chemung group; and, relying upon this evidence, we were compelled to the conclusion that the Catskill group, as recognized and described in the Reports of the eastern districts, was made up, in part at least, of rocks of the age of the Chemung group. Later examinations have confirmed this view, and it now appears that the term 'Catskill group' cannot, with propriety, be applied to any other rocks than those of the higher part of the Catskill Mountains and hills adjacent upon the west. Even limiting the term in this manner, the evidence of its identity with the red sandstone [Blossburg] of the Tioga valley, in Pennsylvania, rests upon the fact of its succession to the Chemung group, if that be regarded as demonstrated."

Very slight consideration indeed will suffice to convince anyone of the fallacy of Hall's position in superposing upon the actual Catskill formation his far-fetched conception of what that formation ought to be, rather than what it really is. What possible bearing upon the definition and limitations of the Catskill in its type region can the miscorrelated Blossburg red beds on the Tioga river have? Such hysterological sophistry is popularly known as "putting the cart before the horse." Both Hall and his subordinates came presently to realize and discard this fallacy; but the Pennsylvania geologists continued to cling to it fondly. As before stated, none of the beds in the Catskill mountains are identical with the Blossburg red sandstone which Hall would make the basis of identification of his "Catskill" in 1870 and 1873.

In the following year (but printed in 1872), the discovery of the first-known stumps of the "Gilboa forest" in 1870 drew forth further observations from Hall in his annual report, preceded by the brief note in the *American Naturalist* of 1870 (pages 563 and 639) in which he assigns the Oneonta sandstone (by name) to the Portage, saying (page 565) that "we are prepared to show that it has no near relation in time to the red beds of the summits of the Catskill mountains, nor to the red sandstones with remains of *Holoptychius*, which occurs along the Tioga and upon the borders of Steuben and Alleghany counties of the State of New York"; but (page 640) Hall leaves the place of the Montrose undetermined. Of the trees, Hall says in his report (page 8): "The occurrence of these trunks in this undisturbed position, would seem to demonstrate that the eastern shore of the Devonian sea, at the close of the Hamilton epoch, was near the eastern limit of the State of New York, and that the dry land gradually encroaching from the east, here supported a vegetation as luxuriant as that of the coal period." In this unequivocal

statement of the Hamilton age of the Gilboa trees, Hall was perfectly correct, although Prosser and others were subsequently deceived by the facial changes that Hall discerned and went back to calling them Ithaca, or else Oneonta. Hall remarks also (page 10): "The difficulties attending the determination of the limits of the formation referred to the Catskill group are still far from being resolved."

On top of this came Professor John Strong Newberry's declaration in 1873 (page 71): "The Catskill formation is for the most part confined to Pennsylvania, scarcely reaching over the line into New York," which seems to mean that Newberry restricted it to the Montrose as base [in 1881, Dr. I. C. White (page 73) included also the Starucca shale]; and Lesley's remarkable table in 1875 (page 58), ascribed to the "New York Geologists," in which he divided the Catskill into the Oneonta and Montrose but put the Oneonta above and correlated it with "X" (now the Pocono), while he made the Montrose the lower member, or "IX," saying of both of these names, in a footnote: "Of Vanuxem, who accepted Catskill from Mather, which turned out to be an unfortunate substitution." This seems to be a characteristically Lesleyan insouciance, not repeated in later writings, and but of passing interest as showing how little the New York situation was known to the men of the Pennsylvania survey even after the work of the brothers Sherwood.

As Dr Bradford Willard, of the present Pennsylvania survey staff, has rightly commented (1933, page 496), the subsequent writings in that State, although frequently noting lateral gradations of marine "Chemung" into continental "Catskill" beds, were nevertheless "always assuming the Catskill to overlie the Chemung." Thus this concept became thoroughly ingrained just at the time it was being completely overthrown by the accumulating field evidence.

In New York, Hall still clung in 1876 to the idea of the Chemung being below the Catskill, which the four years' field work of the Sherwoods (later wholly discredited in its major structural and stratigraphic deductions) had confirmed in his mind. Of the "Old Red Sandstone, or Catskill Group," names now completely synonymous in his usage, he speaks (page 80) as follows concerning the Catskill region, the words in brackets being emendations in Hall's own handwriting in my copy: "After several visits to this region, and notably one in 1857, with Sir William E. Logan and Andrew C. Ramsay (the latter now Director of the British Geological Survey), the question of the Geological Age of this great accumulation of strata assumed a still more important aspect;[,] and the question [object] had never been lost sight of; though for many years it had been quite impossible for me to undertake the investigation.

"Referring to the Geological Map of New York, of 1843, a large area is colored as Catskill Group without indication of Geological structure." Indeed, we may note, not only this map, but even the latest one of 1901 (see figure 9), shows the western boundary of the Catskill, which is in horizontal strata in an area of high relief, as running across country regardless of topography; yet this is after all truly expressive of the abruptness with which the red-beds fade into marine beds through a large vertical thickness along a definite north-south line. But continuing: "Geological Surveys have been carried on with too much haste, and under the pressure of necessity, from limited time; [we turn over to page 81] therefore it was, that we were compelled to content ourselves with determining the limits of formations, and not the structure, which required long and careful investigation." Then, going into details of Sherwood's field work, he presently says of the "belts of red rock" that these belts (page 82) "have, in some localities, been so far eroded as to . . . [have] penetrated deeply into the rocks of the Chemung Group." And lower down on the page: "The section exhibited, crossing the Catskill range from Schenevus to Glasco, is on a line south of the culminating ridges, and therefore does not present the highest points of the range. The lower rocks of the section are of the Chemung Group; . . . The lower beds shown, of Portage and Chemung, have a thickness of more than two thousand feet; while the red rocks above, [over to page 83] which may be referred to the Catskill, are about three thousand feet thick, and the higher beds, of Vespertine, extending to the summit of Round-Top, may be reckoned at about eight hundred feet." Adding in a footnote: "That the entire mountain elevation above tidewater does not exceed four thousand feet, is due to the dip of the strata, which makes the elevation so much less than the thickness."

Unfortunately this section was never published, nor the map. Our understanding of the thickness given, and the limits selected, is readily obtainable, however, from Sherwood's measured section down the Kaaterskill clove, from the summit of Roundtop mountain to Palenville, published by Sherwood in 1878 and reproduced in entirety by Ashburner in 1878 (pages 218 and 219) and by Dr Amadeus William Grabau in 1906 (pages 275 to 276). Hall's combined figures for Vespertine and Catskill (as he understood them), given above, are 3800 feet. Sherwood's section, reaching just to Palenville, adds up to $3481\frac{3}{4}$ feet, though Hall in 1879 (page 15) calls it 3800 feet, and this ends at the foot of the mountain, approximately 1600 feet lower in altitude and in stratigraphy than the Mountain House that

looks down on Palenville village, or roughly 1750 feet below the "third ledge" at the base of the Upper Devonian. Two thousand feet more of "Portage and Chemung" down from Palenville would land us on or below the Onondaga limestone. Something is radically wrong, therefore, with Hall's (Sherwood's) work at this point, for the line of his section must cross the main Catskill front not far south of Palenville and of the type Catskill section. The one thing we can be sure of is that Hall has now dropped his Catskill base down again to the foot of the mountain, reasonably near and perhaps actually intended to be exactly identical to the horizon at which Mather drew it. This is substantiated by the implication of his language, "the red rocks above," which seems to mean that, like Mather, he takes the base of the reds as the Catskill base. Of course he is wrong in putting the lowest reds at (or not more than 320 feet below?) Palenville, for the steep dip of the two-mile-wide belt of reds in the piedmont plain east of Palenville adds at least 750 feet to Sherwood's section.

[Lesley, in 1882, had a good picture of this situation, for he says (page x) of the "Catskill formation, . . . which is at least 5,000' thick," that the "upper layers (3,000'), slightly inclined, project their edges from its southern wall; the lower 2,000', more inclined, crop out in the foot hills in the valley." His figure, all right for the "southern wall," west of Woodstock, is too large, however, for the eastern piedmont belt.

Ashburner in 1878, on the other hand, seems to accept Palenville as the base of the reds. Copying Sherwood, he gives (page 219) 2319 feet of red beds assigned to "IX," though these actually sum to only 1889 feet (which may indicate some slip in Sherwood's figures and help to explain Hall's seeming discrepancy), above 103 feet of fish beds (not assigned) and 105 feet of "Red and green beds, IX-VII." The "VII" must be a slip for "VIII" (Chemung), but in any case would show that he thought the bottom of the reds (the Catskill) had been reached by Sherwood at Palenville.

Curiously, this is also the point where the map of 1842 (and 1844) drew the boundary of the "Catskill Mt. Rocks," the piedmont being mapped in the Chemung.]

But Hall was influenced by Sherwood's miscorrelation of the red shale bed at Palenville with the similar shale bed at the top of the Manorkill falls, Gilboa, which is over a thousand feet higher stratigraphically, and which is there the lowest stratum of solid red color. It is probable, furthermore, that the "two thousand feet" of "Portage and Chemung" were transposed from this Schoharie Kill section below Gilboa; but this again is a direct retreat of Hall from his earlier (and correct) position that the Gilboa rocks are Hamilton. Hall continues (page 83):

"One of the greatest difficulties met with, in this investigation, has been the occurrence of red and greenish shales in the Chemung and Portage beds; and the finding of gray beds with Chemung fossils

at an elevation of at least one hundred and fifty feet above the base of the red rocks, which had always been referred to the Catskill formation. We have finally, however, ascertained, as I believe, the limits of the formation, and though not always in strong contrast with the rocks below, we have been guided both by physical and biological conditions. In the interval between well marked Chemung and typical Catskill, there are beds of intermediate character, and we sometimes find a few fossils of the lower rocks. The same means of distinction do not occur in all localities. In some places the indications of the Catskill are in the red shales and diagonally laminated sandstones. In other places we find a mass of vegetation with or without the presence of the . . . *Cypricardites Catskillensis*. The occurrence of this fossil may, in my opinion, be relied on as characterizing the base of the Catskill formation, while the *Holoptychius* marks the beds above, . . .”

The significance of the last sentence can not be overlooked nor mistaken by anyone who knows the local stratigraphy. *Cypricardites (Archanoden) catskillensis* has its type occurrence at the (local) base of the Oneonta formation at Mount Upton, as was of course well known to Hall, who had said in 1863 (page 108): “Even the type locality of Mount Upton must, I believe, give way before the evidences now accumulating;” and be removed, he then thought, from the Catskill formation, (and referred, we gather, to the Hamilton). Mount Upton is 17 miles nearly west from Oneonta, north of the Susquehanna river and a long way from the Catskills. Because the belt of (Oneonta) red-beds that passes through Oneonta and Mount Upton is overlain on the south by fossiliferous strata that Hall and his successors in the field took to be Chemung, (the Kattel shales of the basal Enfield), Hall himself, not longer than four years before, had definitely rejected from the Catskill, as he then understood the term, the beds whose definitive fossil he now makes the criterion for determining the Catskill base. In so doing he discards completely his former fallacy, but at the same time apparently relapses into his earlier error of calling the sub-Oneonta beds “Chemung.” In the latter reversal, there is unfortunate loss.

Nor did Hall’s flash of insight that (to paraphrase the Mohammedan) “Catskill is Catskill, and Oneonta is part of it,” long endure. His vacillation is curious to witness. In 1878 (page 129) he says of the road from Catskill to the Mountain House that, in ascending the mountain, “we have passed over . . . the Hamilton, the Portage, the Chemung and the Catskill groups, although the lines

of demarcation are not well seen along this route." And (page 215) "that while the base of the mountains consists of Chemung rocks, their greater portion is composed of rocks of the Catskill group;" overlain by "lower carboniferous." But in 1879, after Sherwood's discovery of the fish-beds in the mountain base just above Palenville, Hall goes to the opposite extreme and refers these beds to "the Catskill or Old Red sandstone, which latter had been first recognized near Blossburg in the northern part of Pennsylvania, by its numerous remains of *Holoptychius*," saying (page 14): "On the eastern face of the Catskills, in the gorge known as the [Kaaterskill] Clove, the same beds have been recognized charged with the remains of *Holoptychius*, similar to those of the beds near Blossburg, Pa., and elsewhere."

Moreover, if we read him aright, Hall now implies identity of the Oneonta and the "Catskill" (Katsberg), at Franklin, on opposite limbs of an anticline exposing the Chemung, claiming to have known this since 1863 (or 1844?). At least it is not easy to make sense of his statements otherwise, for, after misquoting Jewett that "the Catskill . . . did not occur within the State," he proceeds (page 13): "A review of the ground during the following year (1863) convinced me that the observations on which this conclusion was based, had been conducted along the line of an eroded anticlinal valley; and that the red rock of the Catskill formation occupied the higher portions of the country on either side. Having made geological sections across this part of the country in 1844, I saw nothing on this review to conflict with the observations made at that time;" continuing with a claim that "these elevated outcrops . . . proved to be, as I had before asserted [where?], synclinals." The only red-beds in the "higher portions of the country" on the north side of Franklin are the Oneonta; and there is no mention of synclines in Hall's publications on this area until 1876.

In the International Congress abstracts of 1880, Hall gives (page 2) the following arrangement of the rocks "qui constituent le systeme de New-York:

"Groupe de Catskill
 Groupe de Chemung
 Groupe de Portage
 Groupe de Hamilton"
 etc.,

including in the last the "Schiste de Genesee" and the "Schiste de Marcellus." On page 4, he says: "Le Groupe de Catskill, avec

ses grandes accumulations de schistes rouges et vert, de grès gris et rouge avec poudingues, est caractérisé par des formes organiques qui nous permettent de la comparer avec l'*Old Red sandstone* d'Europe."

In the same year 1880 (page 290), Hall returns to the old position that "the fossiliferous beds of the Chemung are found lying upon that formation [the Oneonta] between Norwich and Oneonta, . . . and at or near Franklin, where they apparently pass beneath the great red sandstone formation of the Catskills, which is characterized by the presence of bones and scales of *Holoptychius* . . . the [latter] forming the great mass of the Catskill mountains; and to this formation only should the name of Catskill sandstone be properly applied." Again in 1885, supplementing his description of the *Amnigenia* (now *Archanodon*) *catskillensis*, which as he says "is the only mollusk known in the Oneonta sandstone," Hall (page 517) affirms that "all subsequent studies of the localities in Delaware, Otsego and Chenango counties sustain the views published by me in 1870 and 1880. This deposit . . . comes in at about the close of the Hamilton period, or more properly may be regarded as the result of changes which terminated the conditions of the Hamilton group." And ". . . this particular portion of the series apparently merges into the succeeding Portage group, of which, farther west, it forms a part." Then, speaking of the Gilboa stumps, he adds (page 518): "This horizon is probably the equivalent of the lower part of the Oneonta series, and may be regarded as of Hamilton age." Also, beyond:

"The Oneonta sandstone in Otsego and Chenango counties, is succeeded directly by strata bearing fossils of Chemung age, leaving no question as to its relations. All the more recent investigations serve to show that the views heretofore expressed regarding the position and relations of this formation are correct, and that properly it forms no part of the Catskill group, except so far as it is the result of similar conditions which were intermitted at the close of the Oneonta and resumed after the deposition of the Chemung sediments, and which may have once been continuous in some far easterly locality. Moreover, with our present knowledge, the higher beds of the Chemung . . . have no considerable extension to the eastward. . . . I am not aware that the Chemung group has been positively shown to exist on the eastern flank of the Catskills, and the rapid thinning of that formation to the eastward, as shown on the geological map, suggests the possibility of its having thinned

Figure 7 Historical chart, reading from left to right (from top end downward), to show the successive uses of the name "Catskill" as applied by various writers in the typical region of the Catskill mountains (see figures 4 and 5) from west of Catskill village to the highest peak, Slide mountain (4205 feet A. T.), and in neighboring portions of Albany and Ulster counties. Present names and classification "boxed" at each end of the chart, the lowest beds at bottom (left), for comparison with and interpretation of each writer. This chart not drawn to scale. The thickened line above (to left of) each column shows the segment included as "Catskill" by that author, and brings out the striking variations in the use of the name. Mather's numbered subdivisions, at *, are identified as nearly as may be, first for the general section, second for the eastern front, the detailed section; miscorrelations from range to range (see figure 4, cross section) make correct representation of many columns impossible.

At extreme right (bottom) the Oneonta section is duplicated from the following chart (figure 8) for purpose of correlation, and the intervening black lines show the portion of each section that is red-beds. Failure to recognize the lower extension of the reds at east caused many erroneous conclusions in the past.

Catskill Section	HAMILTON				GENESEE		NAPLES		CHEMUNG		Age Name	CATSKILL SECTION	
	Mount Marion	Ash- okan	Kiskatom P	Hill kill	ONTEORA Oneonta	KATSBERG Stony Clove	Slide Mtn	CATAWISSA	MANTROSE				
Catskill	Mount Marion	Ashokan	Kiskatom	Hillkill	Oneonta	Katsberg	Slide Mtn	Catawissa	Montrose		MATHER 1840	Catskill Series	
	Mather's detailed section (Apparently no change intended in limits of Catskill Mtn. series)										1841		
	Erie division (Marcellus to Ithaca)				Catskill division				Lower grits of the coal formation (Higher beds at west taken, for the lower ones at east.)			1843	
	Hamilton		Portage and Chemung		Catskill Mt. Rocks, or Red Sandstone						MAP 1842, 1844		
	Erie division (top variously stated) Catskill division, or Old Red Sandstone (Upper conglomerate may be XII (Pottsville) includes from Genesee shale up)										EMMONS 1846		
	Hamilton and Chemung		Catskill mountain (or Catskill) group, including Pennsylvania No. II and No. I (Referred to the age of the great Carboniferous limestone of the Mississippi valley)								HALL 1859		
	Marcellus	Hamilton	Portage		Catskill mountain (or Catskill) group (The conglomerate "perhaps higher beds" (Pocano))						LINCKLAEN 1861		
	Hamilton group (incl. Portage)				Chemung group (incl. Portage)		Catskill group (I and XI) (Upper limit not clear)				HALL 1862		
					Chemung (May run higher)		Catskill group (Blossburg) (Perhaps only this is Catskill not applicable below level of Mountain House)					1863	
	Catskill Mountain group (All is Chemung except probably some higher peaks are Old Red (Blossburg))										" 1864, 1868		
					(Chemung group)		Catskill Mt. Sandstone (may be Old Red (Blossburg))					HALL 1870, 1873	
	III (Marcellus to Chemung)				Catskill II Montrose sandstone, or Old Red sandstone, or Red Catskill formation				Catskill I Oneonta Sandstone (White Upper Catskill - Referred to Vespertine (Pocano))		NEWBERRY 1873		
	Portage and Catskill or Old Red Sandstone, 3000' (Umbra (a Mouch Chunk) in synclines to west)										HALL 1876		
	Chemung (VIII)		Red beds IX "2315" (1885)		Gray beds X 1385'		Subcarboniferous				SHERWOOD 1878 ASHBURNER "		
	Lower or Red Catskill, IX Upper or White Catskill, X (Vespertine (Pocano in Index))										LESLEY 1878 CHANCE 1880		
	Hamilton	incl. flogs	Port. Chem.	Catskill or Old Red Sandstone of Blossburg		Lower Carboniferous, Vespertine and Umbra					HALL 1878, 1879		
	Old red sandstone or Catskill formation IX 2000' in valley, and 3000' in the plateau				Subcarboniferous or Pocano X in the peaks						LESLEY 1882		
	Catskill Mountain group, from base of Hamilton, 10,000', including upper member of Pocano sandstone										HALL 1883		
	Hamilton group (Catskill group)				Portage Catskill group (No Chemung shown to exist here)						" 1885		
	Hamilton shales Red and coarse greenish gray flaggy sandstones and shales ("Catskill group" of Chemung age) (Upto (Pottsville) conglom)										WILLIAMS 1887		
	(The lower part of this section is down the Schoharie valley)				I Pocano, White Catskill sandstone and conglomerate, 1885'						ASHBURNER 1888		
	Hamilton (Marcellus) (Portage) (Chemung) Catskill red sandstone and shale										PROSSER 1891		
	Hamilton marine fossils plants (of Catskill group)										LESLEY 1892		
	IX Catskill formation (Carboniferous Pocano X 1000' Upper Gray Catskill)												
	Hamilton group (black shales, flogs and shales)		Oncato 1000' (Chemung equivalent)		Dust for one flogstone		(Albany county)				DARTON 1893, '94		
	Hamilton black shales and thin sandstones, 600'		Lower Flag Series, 500'		Chemung red Catskill sandstones, white conglom 1375' (White sandstone 200')		[Catskill rocks continue higher] (Ulster county)				" 1894		
	Hamilton flags? Catskill flags and sandstone										NASON "		
	Hamilton Ononts Catskill sandstone										M'GEE, MAP, 1894 FULLER '92, WILLIAMS '93		
	(Hamilton) Catskill group or formation										DANA 1895 WILLIAMS 1900, '92, '10 (1897)		
	Hamilton	Ithaca	Oncato and Catskill (None is later than "Chemung")								PROSSER 1899		
	Hamilton	Ithaca	(Portage) Oncato Catskill (upper limit at top of "Chemung") (Chemung)								CLARKE & SCHUCHERT CLARKE 1903, 1905		
	Hamilton	Ithaca	Oncato Catskill (Includes nothing higher than Chemung)								MERRILL, MAP, 1901		
	Catskill equivalent to Cattaraugus (and is wholly Devonian)										GLENN 1903		
	Catskill may or may not be continuous with Cattaraugus (Devonian and quite likely Carbonian)										CLARKE 1903, 1904		
	Hamilton	Sherburne lower flogs	Oncato (Portage) Upper flagstone series		Catskill red sandstone, white conglom		(Ulster county)				GRABAU 1906		
	Marcellus & Hamilton	Ithaca and Sherburne	Oncato sandstone Upper flagstone		Red conglomeratic Catskill sandstone (Catskill) hill						BERKEY 1911		
	Hamilton	Ithaca	Oncato (Portage) Catskill (Chemung and perhaps Postdevonian)								HARTNAGEL 1912		
	Hamilton	Marcellus Mt. Marion, red	Oncato sandstones and shales (Portage) 3000'		Catskill (Chemung) sandstone and conglomerate, 1125'						GRABAU 1917, 1919		
	Hamilton Original Catskill formation (Kiskatom (Oncato) (Upper Ithaca) to n. Trillia Catskill (Portage) 4000')				Catawissa (Chemung)		Montrose (Chemung)					CHADWICK 1932	
	Kiskatom (Oncato) ("Catskill")				Oncato		Catskill					" (GSA abstr)	
	(Hamilton)	1. Kiskatom (Ithaca, lower Portage)	2. Oncato (Ithaca, upper Portage)		3. Catskill proper (Enfield, upper Portage)		4. Catawissa (Coyuta, lower Chemung)		5. Montrose (Wellsburg, upper Chemung)		" (Sci) 1933		
	Hamilton	Marcellus	Kiskatom Higher Hamilton		Catskill red beds						KAY & CHADWICK "		
	Bakoven	Mount Marion	Kiskatom		Catskill formation (Oncato, Katsberg (Enfield) (Portage) Seneca)		Slide Mtn (Dandys)				CHADWICK "		
	Bakoven	Mount Marion	Kiskatom		1. Oncato (Sherburne (Ithaca))		2. Catskill (Stony Clove)		3. Catskill (Willsburg, upper Chemung)		" 1934, 1935		
	HAMILTON				GENESEE		NAPLES		CHEMUNG		Age	CATSKILL SECTION	
	Mount Marion	Ashokan	Kiskatom P	Hillkill	ONTEORA Oneonta	KATSBERG Stony Clove	Slide Mtn	CATAWISSA	MONTROSE	Name			
	MARCELLUS	SKAN-LUAL	MOSC. TULLY	SHERBURN	(Ithaca) ONTEORA	(Enfield) KATTEL KATSBERG Von Effen	Dandys	CAYUTA	MONTROSE (Wellsburg)		ONEONTA SECT'N		

Locality	BAR- OVEN	MOUNT MARION	ASH OKAN	KISKATOM	ONTEORA	KATSBURG	CATAWISSA	MONTROSE	Catskill Section	
	MARCELLUS	PANTHER MOUNTAIN	MOS- COW	LAU- REN	SHER- BURNE	ONEONTA (Ithaca)	KATSEL (Enfield)	[CATAWISSA] CAYUTA	MONTROSE (Wellsburg)	
	HAMILTON				GENESEE	NAPLES		CHEMUNG	Names } Age } Oneonta- Montrose Section	
	Hamilton including	Tully	Sherburne	Oneonta	Kattel	(Upper) Katsberg	Catawissa	Montrose	CHADWICK 1935 1934	
	Hamilton	Tully	Sherburne	Oneonta	Kattel	(Upper) Katsberg	Catawissa	Montrose	" (G.S.A.) 1935	
	Hamilton	Tully	Sherburne	Oneonta	Kattel	Katsberg	Catawissa	Montrose	" (Pan-Am.) 1933	
	Marcellus	Panther Mtn.	Moscow	Laurans	Sherburne	Ithaca			COOPER 1933-34	
	Hamilton	Sherburne-Ithaca	Oneonta	(Enfield)	Chemung	Catskill			GOLDRING 1931	
	Hamilton	Sherburne-Ithaca	Oneonta	Portage	Chemung	Catskill			HARTNAGEL 1912	
		Ithaca	Oneonta	"K" (Kattel)	Catskill (includes the [Montrose])				WILLIAMS 1909	
		Ithaca	Oneonta	as (Catskill)	Pre-Chemung (Catskill)	Typical Catskill			" 1903	
	Hamilton	Portage	Unadilla forma	Sherburne-Ithaca	Oneonta	Chemung	stage		PROSSER 1903	
	Hamilton	Ithaca	Oneonta	(Portage)	Chemung	Catskill			CLARKE 1903 MERRILL, MAP, 1901	
	Hamilton	(Genesee)	Oneonta	(Portage)	Chemung	(Catskill)			CLARKE & SCHUCHERT 1899	
	Hamilton	Sherburne and Ithaca	Oneonta	Chemung	Catskill				PROSSER 1899 1897	
	Hamilton	Sherburne (Lower Ithaca)	Oneonta	(Upper Ithaca)	Chemung				CLARKE 1897	
	Hamilton	Oneonta	Portage	Chemung	Catskill (of Chemung age)				DANA 1895	
	Hamilton	Oneonta	sandstone	Chemung sandstone	Catskill sandstone				MCGEE, MAP, 1894	
	6 Hamilton formation	S. fauna intermediate between Hamilton and Ithaca	Oneonta	as Catskill	Portage	Chemung	formation		WILLIAMS 1894	
		Ithaca (Naples)	Oneonta	(Portage)	Chemung	Typical Catskill			CLARKE 1894	
	Hamilton	Ithaca (Portage)	Oneonta	Chemung	of Vanuxem, including Oneonta and Montrose				PROSSER (AJS) 1893	
	Hamilton group	Oneonta	Chemung	Catskill group					DARTON 1893	
	Marcellus Hamilton	Ithaca	Oneonta	Chemung	or Montrose				PROSSER (W.S.) 1893	
	Hamilton shales	Oneonta	Chemung	Catskill group					HALL 1893	
		Oneonta (Portage)	Chemung	(Catskill)					" 1892	
		Oneonta (Portage)	Chemung	[Upper] Catskill, including Montrose					LESLEY 1892	
		Paracyclus lirata fauna	Oneonta	Chemung	Catskill group				WILLIAMS 1886	
	Hamilton	Oneonta	Chemung	Catskill					HALL 1886	
	Hamilton group	Oneonta	Chemung	Catskill group					" 1885	
		Oneonta	Chemung	Great red sandstone formation of the Catskills					HALL 1880	
		Chemung	[Oneonta = Catskill]	(on opposite side of an anticlinal valley)					" 1879	
				IX "Montrose"			X "Oneonta"		LESLEY 1875	
				Catskill confined mostly to Pennsylvania.					NEWBERRY 1873	
	Hamilton (upper part called "Chemung" on map)	1842	Oneonta	Chemung	Catskill Mt. Sandstone [Blossburg] and both Sandstone and conglomerate of the top of the Catskill mountains.				HALL 1870, '72, '73	
		1844	Oneonta	Chemung	Catskill mountain group is all Chemung				" 1864	
	10. Hamilton group (formerly mapped as Chemung)	Portage	Chemung	Chemung (No. 9 [IX]) / Catskill (IX & X)					" (" 1863)	
		3. Shale and sandstone	8. Red shale and sandstone	11.6. Chemung	No part is European Old Red Sandstone (?)				(JEWETT 1862)	
	Erie division	Catskill division or Old Red Sandstone							EMMONS 1846	
	Hamilton Group	Portage and Chemung Groups	Catskill Mt. Rocks, or [Old] Red Sandstone						MAP, 1842, 1844	
	Marcellus Hamilton	Tully, Genesee, Portage & Ithaca	Catskill group						VANUXEM 1842	
	Black slate	21. Shales of Catskill group	22. Sherburne group	Oneonta	(Perhaps? included in Old Red)			Old Red Sandstone	CONRAD 1841	
	Marcellus	Upper Marcellus	Shale, Ham-ateles	Ham-ateles	Moscow	Tully	Sherburne and Ithaca	Oneonta sandstone or Montrose	VANUXEM 1840	
	Old Red Block slate	8. Dark-colored shales	9. Olive sandstone	Old Red Sandstone?					CONRAD 1839	
	MARCELLUS	PANTHER MOUNTAIN	Moscow	Laurans	SHER- BURNE	ONEONTA (Ithaca)	KATSEL (Enfield)	[CATAWISSA] CAYUTA	MONTROSE (Wellsburg)	Names } Age } Oneonta- Montrose Section.
	HAMILTON				GENESEE	NAPLES		CHEMUNG		

Figure 8 Historical chart, second part, reading from right to left (from bottom and upward), to show the variant interpretations of the Oneonta-Franklin-Montrose section (see figures 2 and 3) by successive writers, with the limits of the "Catskill group" of Vanuxem, and later applications of the name "Catskill" in this section as indicated by the thickened line at upper (left) side of some of the columns but omitted from others where the upper limits are not stated. Some writers swung the section eastward to the high peaks at top of the section of figure 7, preceding, and thus into wholly red-beds; others followed down the Susquehanna to Montrose, therefore partly through marine equivalent beds, as evident from figure 3. At †, the order of arrangement of the local members of Conrad 1841 is as corrected by Prosser 1893 (A. J. S.; 214), who has pointed out that Conrad used "Sherburne" and "Oneonta" in senses different from Vanuxem. At §, the "Catskill" of Williams and of Dana may mean Montrose, their Chemung the Cayuta, their Portage the Enfield, depending on which route they were considering; but compare Williams 1886.

At extreme left (top) the Catskill section is duplicated for correlation, the unlike downward limit of the red-beds in the two sections being indicated by the black lines confronting. The Catskill reds of Mather's type section are thus seen to be in Vanuxem's ("Third") district wholly marine deposits.

out entirely before reaching the Hudson river valley." Then follows this:

"Catskill group,
 Chemung group,
 Oneonta { Portage group,
 { Hamilton (Upper),
 Hamilton group,
 Corniferous limestone,
 Oriskany sandstone."

Subdivision. Thereafter the New York publications were dedicated to the thesis that there is a Catskill formation separate from and above the Oneonta, though Lesley, in his final summary report of 1892, recapitulates the New York situation thus (on page 1365): "The Oneonta sandstone beds, instead of being at the top of the Chemung, constitute in Prof. Hall's present opinion the true base of the great Catskill formation, in fact a Lower Catskill, deposited before the Chemung. But this is the horizon of the Portage." (On page 1337): "Farther east it [the Portage formation] turns into the Oneonta sandstone formation, forerunner of the Catskill, IX." But afterwards, in a footnote, Lesley expresses his own conviction (page 1605) thus: "The fact is, the whole Chemung mass is merely a middle division of the great Catskill mass, for in New York the Oneonta formation underneath the Chemung is as much Catskill as the mass above the Chemung." Which is absolutely true; or, rather, it is more than true, if we are comparing the Oneonta beds with those that are truly post-Chemung, since the latter are not Catskill at all.

In 1886, Hall published (page 11) a brief report made by Charles Emerson Beecher, Dr James W. Hall and Charles Edward Hall, stating: "These observations confirm statements previously made to the effect that the Catskill is not the equivalent of the Oneonta, sandstone and that the Chemung group overlies this series and intervenes the Oneonta sandstone and the Catskill group proper, as developed in the Catskill mountains." To this is appended a vertical section at Lyon brook, labelling the strata downward as "Chemung group," "Oneonta sandstone," and "Hamilton gp." On page 4, Hall states: "the results . . . clearly show that the Oneonta sandstone rests upon well marked Hamilton strata, . . ." but in this he was mistaken, in as much as the beds in Lyon brook are not Hamilton but Ithaca, with *Spirifer mesaerialis* and *Paracyclas lirata*

(as his assistants reported). Lyon brook is about 25 miles due west of Oneonta.

In the same year, 1886, Professor H. S. Williams showed that the Chemung base is hundreds of feet above the Oneonta sandstone, and in another paper Williams protested against the separation of the Oneonta from the Catskill, saying (page 198): "In his remarks upon the classification of the rocks of the Devonian, Professor Hall appears [1885] rather to add to the confusion than to alleviate it. The Oneonta reds and grays, although lithologically indistinguishable from genuine Catskill rocks, and containing unmistakable *Bothriolepis* scales (a genus hitherto regarded as characteristic of the Catskill deposits), is distinguished from it [by Hall], 'and forms no part of the Catskill group' (page 518)." A year later, 1887, Williams states (page 20) that "finally [that is, in the Catskill mountains] the red and coarse, greenish gray, flaggy sandstones and shales . . . fill the whole interval from the Hamilton shales upward to the [Pottsville] Conglomerate," referring these (page 27) to "the Catskill group," and saying further:

"In regard to the Catskill group, my studies have led me to believe that the Catskill red rocks of the east offer evidence of having been contemporaneous with a great portion of the Upper Devonian rocks." Of the beginning of Catskill sedimentation, he says further (page 27) that "there is reason to believe that in Sullivan County, New York, it was as early as the reign of the Hamilton faunas," [which should be still more true in Greene county, to the northeast]; closing with (page 28): "I take it there is nothing inconsistent in the view that Catskill rocks were being deposited in the Appalachian region at the same time that Chemung rocks were being formed over western New York areas." But he mistakenly claims (page 27) Hamilton rocks to lie next under the Oneonta in Chenango and Otsego counties. And in 1891 (page 19) he went back on the equivalency of Catskill to Chemung and put the former in the "Pennine carboniferous."

Professor Prosser, in 1891 (page 364), confirmed Williams as to the nether limit of the eastern reds, saying: "in the eastern Catskills, . . . along the line of the Ulster and Delaware R. R., the last marine fauna is composed principally of Hamilton species, above which are fossil plants of Hamilton facies; then non-fossiliferous shales and sandstones in which the first of the reds appear." In this he was nearer the truth than he was later, in 1899, as was shown by Doctor Grabau in 1917 (page 954).

Still nearer was Hall in 1892 in saying as reported (page 194): "the 'Oneonta [Oneonta] Sandstone' passes eastwardly into the lower

Catskill and westwardly into the Portage. . . . The merging of the Catskill, lithologically in the Portage, to the westward is very significant. . . ." In that year, Professor John James Stevenson, mistaking (page 23) White's "Montrose sandstone" for Vanuxem's, drew (page 14) his Catskill base above White's "Montrose red shale."

In 1893, five years before his death, and a half century after his "final report," Hall said what appears to be his last word on the subject, summarizing the history of the investigations as follows (page 33): "One of the most notable and interesting questions in discussion at the close of the survey, had reference to the Oneonta sandstone and its relations to the Chemung and Catskill groups." (Continuation of this quotation will be found on pages 25 and 26 of this Bulletin.) "Mr. Mather, in his final report, used the term Catskill Division to include the Montrose and Oneonta sandstones of the annual . . . reports and . . . gives in great detail an account of the lithological character of the series of strata constituting the successive terraces of the eastern mountain slope of the Catskills. [Page 34] My first examination of the Oneonta region in 1844 disclosed the fact that the Oneonta sandstone, described as lying upon the Chemung group [Vanuxem says Ithaca], really rested directly upon the shales of the Hamilton group, and the quarries cited by Vanuxem as containing Chemung fossils [an untruth] really contained only characteristic fossils of the Hamilton group. This erroneous idea of the order of succession [for which Hall himself had been responsible] had entered into the discussions of the relations of the Hamilton and Chemung groups, and the arenaceous beds of the former group in that region of country had been referred to the age of Chemung group. Farther examination on the hill summit, in the neighborhood of Oneonta, showed very clearly that rocks carrying characteristic Chemung fossils rested directly upon the top of the Oneonta sandstone. In exploring the country further south and south-eastward, there was found a belt of gray and greenish-gray shale and sandstone carrying Chemung fossils, lying above the Oneonta sandstone, and succeeded above by red marls and gray grits and sandstones which formed a part of the Catskill group in its western extension. Repeated examinations of this region through several years, although cursory in their nature, confirmed these first observations; but it was not until 1870-71 that the country was mapped with anything like accuracy in regard to the relations of these formations. This map, however, was never published, . . .

"In 1880-81 still further progress was made in the investigation of the Oneonta region and the extension of these formations to the

east and west. This work, chiefly done by Mr. Andrew Sherwood, under my immediate direction and supervision, confirmed and extended the conclusions reached in 1870, and in previous years."

I have previously related (see pages 40 and 41) how Vanuxem had been coerced by Hall into accepting the latter's views, and how Vanuxem had himself stated (1842, page 192) the Ithaca age of the beds beneath the Oneonta sandstone, to which may now be added his remarks on another page (180): ". . . it was mentioned that an exception existed as to the Chemung group being the lowest rock of Broome county. This exception exists at Port Crane on the Chenango canal, near the north line of the county. There rocks appear, having similar fossils to those of the lower rocks which are quarried around the village of Norwich, and those exposed in the sides of the brook to the west of the village of Oneonta." It is clear from this that Vanuxem knew that these localities are pre-Chemung, as they all are—that at Port Crane being low in the Enfield, and those of Silver creek, west of old Oneonta (see Prosser 1899, page 82), and Norwich being in the eastern extension of the Ithaca fauna as Vanuxem was well aware. Nowhere can I find that Vanuxem mentioned any quarries with Chemung fossils beneath the Oneonta beds. It has seemed worth while to take this space to defend a careful worker from this attempt of an otherwise great man to shift his own mistakes to the shoulders of a colleague long dead (Vanuxem died in 1848) as well as to predate the discoveries of Mr Way of Franklin in 1862 back to 1844 (in order to anticipate Emmons 1846?) and appropriate them as his own. Careful reading of the excerpts already quoted will show that it was long after 1844 before the first inkling of these disillusionments appears in Hall's writings (in 1880 Hall wrote: "My first observations in this part of the country . . . were made in 1844, but at that time only for the collection of fossils"), and still longer before he mentions 1844 as the time of them (see page 49). From my own field work in mapping the Oneonta quadrangle I think it is safe to say further that no trace of the overlying Kattel shales occurs anywhere in "the neighborhood of Oneonta." Besides these misstatements, Hall was in error as to the Hamilton age of the underlying beds, whereas Vanuxem was right in calling them Ithaca.

Renewed field work. The relations of these beds were taken up at this time by two new workers in this area, Nelson Horatio Darton and Charles Smith Prosser; and in this very report of Hall's appears Prosser's first paper proving that the fauna beneath the Oneonta is not Hamilton, but lies (page 142) above the Genesee, a relationship

confirmed in 1894 (page 750, figure), and 1897, by John M. Clarke. Prosser's further work (see chiefly 1895 and 1899) was concerned largely with showing how the reds come in at lower and lower levels to the east, and otherwise, through failure to recognize concomitant facial changes in the marine beds, it was reactionary, calling the eastern Hamilton "Sherburne and Ithaca" and even "Oneonta," while the supra-Oneonta beds were put back in the "Chemung."

Darton's efforts (1893) were directed to tracing the higher divisions, especially the supposed "Chemung" (Kattel), but by giving insufficient attention to the dip he lost the trail and stepped down toward the east; thus he finally (page 207) brought this "Chemung" around the mountain front below the Mountain House, in approximately the lower part of the Tully. [Darton's mapping was followed in the State maps of 1894, 1901 (see figure 9)]. Here, then, was supposed at last to be the long-sought dividing line between the Oneonta and the Catskill in the type section of the latter, namely several hundred feet down in the Kiskatom, the Middle Devonian or Hamilton reds. And there the matter rested.

But (Darton's figure 1, page 204) the Oneonta was kept by him in the Catskill. Mr Darton tells me that he did the whole of this work on foot. It was a herculean task, through the mountains, and his deviation seems to have come through a blunder made by Hall in identifying as *Spirifer disjunctus* (a Chemung species) a shell from near the mountain pass four miles west of Durham that could only have been the *Spirifer mesastrialis* occurring there near the top of the Hamilton (Moscow member). Otherwise Darton's observations are precise and penetrating, especially his illuminating but generally overlooked statement, so abundantly verified today, namely (page 208): "The lowest red beds have been used as a criterion of discrimination between Chemung and Catskill, but they vary in stratigraphic position from the upper beds of the Hamilton, in eastern New York, to near the base of the Lower Carboniferous, in north-western Pennsylvania, a difference in horizon of several thousand feet."

Thus began a period of several years of almost feverish field activity in the Upper Devonian rocks of central and eastern New York, in which others participated including John M. Clarke, later the State Geologist of our State. Their work served to impress ever more deeply the conception that the Oneonta beds are the lowest reds in this period, and that they come down into Albany county (Darton, 1894, pages 236 and 238; and 1897, map; Prosser, 1899, pages 240 to 264) and around the eastern slope and base of the

Catskills in Greene and Ulster counties (Darton, 1894, page 297; Prosser, 1899, pages 265 to 303), being there overlaid by the Catskill in the limited sense in which they (and Hall) understood it. As to what lay beneath this Oneonta, they disagreed wholly, for Darton correctly had Hamilton below and at least part-way up into it, while Prosser maintained that the Sherburne sandstones and possibly a remnant of the Ithaca (from which on his map he did not discriminate the Sherburne) persist below the reds clear through to Port Jervis, the Delaware river, and into Pennsylvania.

But assuming, apparently, that the strata have equal altitudes above sea under the Mountain House and on the highest summits in Ulster county, Darton (pages 491 to 492) selected quite different limits in that county for his divisions. His "Oneonta" top (upper flag series) instead of being down in the Kiskatom is now carried up above the Stony Clove (Kattel) sandstones, which are the productive flagstones through a long stretch of the Esopus valley and its tributary alcoves, and which overlie the Oneonta beds. Nor does he call the overlying Katsberg beds with the Wittenberg sandstones and conglomerates "Catskill" but "Chemung" for over 1375 feet, and reserves the name "Catskill" for the white Slide Mountain conglomerate only, some 350 feet thick, capping the highest pinnacles, though he explains that the Catskill of Mather and Vanuxem embraced the beds below to the bottom of the "upper flag series" or Oneonta of his terminology, which he makes 3000 feet thick—the total thickness of the strata he meant to so include is considerably more than 4000 feet, for his sections fail to show the inward dip of four degrees across several miles southeast of these peaks. This restriction of Catskill by intent to the Slide Mountain conglomerate, and its overlying beds to west (page 364), or to those now believed to be the only ones of Chemung age in this area, is most unusual and is of special interest in that these white conglomerates are certainly the very first ones that Mather would have rejected from his Catskill, besides that they were unanimously assigned to the Pocono by all the Pennsylvania men.

[Doctor Grabau (1906, pages 302 to 303; 1919, pages 426 to 427 and 470) and Dr Charles Peter Berkey (1911), pages 37 to 38), both of Columbia University, have each copied Darton's section, with minor changes, but have placed the Catskill base at the top of the "Oneonta" (upper flags), being the top of the Stony Clove flagstones, though Berkey (page 37) emphasizes the conglomerate aspect whereas Grabau says (1906, page 227) that it "consists chiefly of red rock."]

In actuality, however, Darton, like the others, mistook the rather similar but lower Wittenberg conglomerates on neighboring peaks to east and south for that on Slide. But he wisely looked for the

Slide Mountain layer to the west, and recognized that it there would be turning red. As to current notions he rightly says (page 362): "The idea which has so long prevailed that the higher peaks of the Catskills are capped by remnants of a great sheet of conglomerate is erroneous, . . . for the conglomerates are in streaks and at several different horizons." Frank Lewis Nason, in the appendix (page 378), still uses Catskill for all the reds, while in the same year Williams (1894, page 144) states plainly that "along the Hudson River valley, the Catskill formation occupies the whole of the Upper Devonian. . . ." And Prosser says (1899, page 288): "the base of the Catskill, or Oneonta formation as we have still called the lower part of this mass of rocks in Greene co." More specifically he speaks of them (page 290) "as one formation, to which would be applied the name Catskill in the sense in which it was used by Mather for this region."

No further description or rectification of the type section was published thenceforth until very recently. Writers merely took one side or the other as to including or excluding the Oneonta, and as to whether the subjacent strata are Hamilton or Ithaca-Sherburne, although mostly inclining to the latter, the viewpoint of Prosser. Dr William John McGee's large geological map of the State, 1894, has Catskill and Oneonta colored separately and sundered by a tongue of Chemung as far east as Greene county (Cornwallville), then the Oneonta vanishing into the Catskill on entering Ulster county. But Hamilton comes beneath the Oneonta throughout. On the other hand, Dana's Manual in its last edition (1895, page 576) speaks of "the sea-border deposits . . . which were in progress during the Upper and partly the Middle Devonian, [that] make now red sandstone and conglomerate, and constitute what is called the Catskill formation . . . parallel in its deposition with that of the . . . Chemung and Hamilton periods, to the westward." In this, (pages 603 to 605), he was following Williams, and Darton. Both of these publications, however, antedate the maps and detailed accounts of Prosser, which appeared in 1897 and 1899, as above quoted.

Late in the latter year, 1899, and reprinted in 1900 in two other channels, came Clarke and Schuchert's revision and reclassification of the Paleozoic rocks of New York, in which (page 875) the "Oneonta beds" were placed as a "local facies" of the "Portage beds" in the (new) "Senecan group," and the "Catskill sandstone, local facies" of the "Chemung beds" as the (new) "Chautauquan group." But (page 878) this explanation is added: "Catskill sandstone. This is an approximate expression of the value of this formation.

Catskill sedimentation doubtless began as early as Portage time, its representation during which is expressed in the term, Oneonta beds." This rather equivocal statement is not much clarified by Clarke in the following year (1901), when he says (page 201): "The Oneonta-Catskill sedimentation in its fullest development doubtless represents time from at least the close of the Hamilton stage. Prof. Hall was disposed in some of his writings to regard the upper part of the Hamilton series . . . as replaced eastward by the Oneonta beds. Present evidence may not fully corroborate this interpretation." But he admits that the red-beds arrive earlier eastward. And in 1900 Williams reaffirmed (page 594) his belief that "As low as the horizon of the Hamilton fauna the sedimentation assumes the arenaceous and sometimes the reddish character of the typical Catskill rocks."

Dr Frederick James Hamilton Merrill's geological map of the State, 1901, unfortunately accepted Prosser's erroneous and reactionary views as to the eastward extension of the Ithaca and Sherburne beneath the red beds of the Hudson valley, and followed him in subtracting these from the Hamilton outcrop all the way from the Schoharie valley to the Delaware valley below Port Jervis. Otherwise (see figure 9) its lines are practically those of the McGee map (1894) in the Catskill Mountain region. Neither of these maps took any notice of the claimed post-Catskill strata in this area, or of the strips of supposed Chemung exposed by erosion along the axes of Sherwood's "anticlinals" in Delaware county, but spread a solid "Catskill" color-pattern over the whole. In Merrill's bulletin describing his map (issued in 1902, table opposite page 34), the arrangement of these higher beds is:

"Chemung	<i>Catskill</i>
Portage	
Ithaca	
Oneonta	
Genesee	
Tully	
Hamilton"	

In this same year, Williams (page 420) reiterated: "The Catskill formation begins at the horizon of the Hamilton in the eastern sections," while Myron Leslie Fuller (page 664) likewise affirmed: "In the Catskill Mountains the lowest red beds rest on Hamilton." But, in 1903, Fuller's colleague, Leonidas Chalmers Glenn, looking (page 967) for "the Catskill or its equivalent" in the Olean region,

claimed (page 985) for the Cattaraugus reds, which he wished to keep in the Devonian, "their reasonably certain stratigraphic equivalence with the red beds of the Catskill to the east," a correlation immediately taken up by Clarke in succeeding pages (997 to 998) and in 1904 (page 208) as proof to him "that the upper stages of the typical Catskill are postdevonic."

A new slant had been given to the age of these post-Oneonta reds in New York by Williams in 1886, in showing that the fauna overlying the Oneonta is much older than Chemung, which nevertheless, was persistently denied in the state publications thereafter by Hall, Clarke, Prosser and Darton and on the maps of McGee and Merrill, as well as by Lesley, and found support only in Dana, 1895 (page 603: "the *Oneonta sandstone* . . . is overlaid by beds containing Portage fossils; and in some places, Chemung species") unless we take as assent the words of Prosser in 1893 (page 213, not the State publication) about "the Oneonta sandstone, which in that region is overlaid by rocks containing at the base a Portage fauna, higher [up] Chemung species and finally is capped by the Catskill stage."

Between the Oneonta sandstone and the lowest true Chemung fauna, that of *Camarotoechia contracta* and *Spirifer disjunctus* high on the hill at Port Crane, near Binghamton, Williams (1886, see Section IX of chart) put four other faunas called "modified Hamilton," namely those of *Atrypa reticularis*, *Leiorhynchus globuliforme*, *Tropidoleptus carinatus* and *Spirifer mesaestrialis*, all of which are now known to be Enfield, and the upper of which soon pass eastward into the red-beds called Catskill around Franklin.

In 1894 Williams called it "a modified Ithaca fauna" above the Oneonta, and finally Williams announced in 1903 (page 99) that the supposed "Chemung" wedge or "fossiliferous zone above the Oneonta, in Chenango and Otsego counties, is the stratigraphical equivalent of the barren 300 or 400 feet [now the Enfield] of the Ithaca section . . ., which lie between the fossiliferous Ithaca formation with the *Productella speciosa* fauna and the Chemung formation with the *Spirifer disjunctus* fauna." On page 120 he adds: "The Oneonta . . . is the equivalent of the lower Catskill." Still more light on this was thrown by him and Kindle in 1909, in the Watkins Glen atlas, which, although beyond our area, revealed the rapid eastward thickening of the strata and the eastward descent of the Catskill base, replacing the Chemung until that is already completely red in the Chenango valley, while the supposed "Chemung" there is all pre-Chemung Enfield with the *Leiorhynchus globuliforme* zone (Kattel shale) as the supra-Oneonta formation.

RECTIFICATION OF CORRELATIONS

This important contribution of Williams was ignored, however, at Albany and in the textbooks. The "Chemung" age of the (restricted) Catskill and the "Portage" age of the Oneonta, whether considered a subjacent formation or a lower part of the Catskill, remained henceforth undisputed (compare Barrell, 1913, pages 429, 431: "now universally accepted") until 1930, with still a lingering allusion (Clarke, 1915, page 128) to the possible presence of post-Devonic beds in the high Catskill peaks.

Yet there is note to be made of the fact that in William John Miller's diagram (1914, figure 6 on page 17) from Black Dome, highest peak on the Catskill front, westward to the Susquehanna, the summit strata [Stony Clove sandstones] on that peak are correctly brought down, on the west dip, to the level of the marine beds [Kattel shales and flags] at Delhi, and this does not seem wholly accidental.

In agreement with Williams, Darton, and the early work of Prosser (1891), moreover, Grabau in 1917 reasserted the Hamilton age of the sub-Catskill beds, Darton's "lower flag series" in Ulster county, later mistaken by Prosser (1899) for the Sherburne. Grabau now renamed these the Ashokan beds, saying (page 954) that they "represent the non-marine terminal phase of the Hamilton . . . and . . . contain no fossils other than plant remains, and they pass downward into the normal fossiliferous marine Hamilton," which he therefore names the Mount Marion beds. But he still retained (1919, page 470) all the overlying (and intergrading) reds in the Oneonta (Portage series), although Williams in 1910 had very definitely affirmed (page 285) of "Catskill sedimentation" that "In eastern New York it began while the Hamilton marine fauna was still present and cut it off."

The excellent and pleasingly instructive monographs of Dr Rudolf Ruedemann (1930) and Winifred Goldring (1931) show to how recent a date the old ingrained ideas as to the Catskill sediments have passed unchallenged.

At the Toronto meeting, in 1930, George Halcott Chadwick announced (pages 6 to 7 of the abstracts): "The name Catskill, as applied to a continental facies of the Upper Devonian in New York and Pennsylvania, has come to imply a wide-spread equivalence of these beds which does not exist. Field studies are now closing the gap in correlation between the type section in the Catskill Mountain front west of the Hudson River in Greene County, New York, and the marine beds of [page 7] central New York, with the surprising

result that much or all of it is proving to be of "Portage" (Enfield) age, thus putting the Catskill below the Chemung instead of above it. The so-called 'Catskill' on other meridians, of various horizons, must therefore be sharply discriminated."

In the program for the Tulsa meeting, in 1931, Chadwick has two abstracts (page 61), stating of the (supposed Oneonta) red-beds that "certain thin zones with marine fossils persist far east around the northern Catskills, within the red beds. Careful field tracing of these zones has now led to even more radical changes in correlation on the Catskill Front than those announced last year. Vanuxem's early correlations are vindicated." This paper is still unpublished. The fossil zones referred to are of Hamilton age, as determined within the following year by Dr G. Arthur Cooper and subsequently published by him in 1933. Chadwick's other abstract (page 61) suggested that the Pocono "may represent only a still farther landward facies of the upper Devonian than the red 'Catskill,' and like that be progressively older to east" where the Catskill "now proves to fall so much short of the Devonian summit as developed farther west."

A year later (1932), the program of the Cambridge meeting (page 12) contained the further announcement by Chadwick, referring to Cooper's field work, that: "In the Hudson valley the original Catskill beds are found to extend from lower Hamilton into the Portage, and more of them are middle Devonian (Hamilton) than I had supposed. None here is as late as the Chemung. Moreover, instead of the lower half of the red-beds being the Oneonta, as distinguished from an upper 'restricted Catskill' half, the true Oneonta, corresponding to the Ithaca formation in age, is proved to belong far up on the mountains, in the middle or upper part of the . . . Catskill. Since the name Kiskatom has been elsewhere employed for the Hamilton reds, this name will replace 'Oneonta' as generally understood in the Catskill front, while Oneonta will here replace 'Catskill' as usually limited, except perhaps at the extreme top."

Cooper's abstract in the same program (pages 47 to 48) states: "East of Schoharie Valley all of the fossiliferous Hamilton appears to be of Marcellus age, the Skaneateles, Ludlowville, and Moscow formations, in this order above the Marcellus, having become continually sandier and having passed into continental and red and green beds [page 48] just east of Schoharie Valley." The "well known tree beds of Gilboa" have proved "upper Hamilton (Moscow) in age. From Gilboa . . . the Portland Point [basal Moscow] was traced into the midst of the red beds at Potter Hollow, near Durham, Greene County, showing a considerable thickness of these

red beds, formerly regarded as upper Devonian, to be Hamilton in age." None of Prosser's "Ithaca" in the Schoharie valley turned out to be such. Doctor Willard simultaneously reported (page 37) similar downward extension of red-beds into the Hamilton of northern New Jersey.

The introduction of the name "Kiskatom," above mentioned, had been made three months earlier by Chadwick in a long (popular) article in the Eastern States Oil & Gas Weekly for September 2, 1932, in which the salient facts brought out are the five facies and their deceptive overlapping relations, the great eastward thickening of the beds and the proofs of their lateral gradations from one facies into another as a law, not an occasional exception, and also the necessity for new names expressing the actual time relations of the beds. For this purpose (page 7); Conrad's name "Blossburg" was resuscitated, as also Vanuxem's "Montrose," while the name "Catawissa" was introduced for the reds of lower Chemung (Cayuta) age. The "supposed 'Oneonta' in the Catskill front" was ascribed in part to the lower Ithaca (Otselic), and "still under these reds, in Albany and Greene counties, are reds once included in the Catskill that prove to be of upper Hamilton age—the Kiskatom red beds we shall call them." The article continues (page 7): "As first named in the Catskill front (facing the Hudson valley) the Catskill formation included at base beds now found to be of Hamilton age. Its top apparently falls short of any true Chemung, though in the western Catskills there are Chemung reds (Catawissa) along the Delaware, above the true Catskill (Portage) reds.

"Excluding the Hamilton (Kiskatom) reds at base, which occur only in the Hudson valley, the true Catskill becomes equivalent to the (marine) true Portage with the underlying true Genesee. As a red formation, this true Catskill does not get west of the Susquehanna except as its Oneonta member continues north of that river to the Chenango valley; nor does it reach very far into Pennsylvania on the southern outcrop, probably not to the Lehigh." The summary states: "The type Catskill area is at the east, where the red beds of the original Catskill formation are of early age (Portage and older)." (A typographic error is corrected.)

Because of the appearance of this article in a rather ephemeral journal, and in popular phraseology, it can not be claimed as a scientific publication enjoying the right of priority. Its essential conclusions were reprinted four months later in Science for January 20, 1933, where Chadwick said (page 86) that the name "Kiskatom" had been employed for the "lower portion of the original Catskill

group that belongs to the middle instead of the upper Devonian. This is the portion formerly falsely identified as 'Oneonta'; the true Oneonta has been found to go much higher in the Catskill front and to correspond largely with the so-called 'restricted Catskill' there." Further, Doctor Cooper's work "has shown that the top of the Hamilton . . . goes even higher in the red beds than I had supposed."

Without having had opportunity at that time to review the early literature in sufficient fullness, and thinking that historic continuity would be served in still keeping the "Catskill" above the Oneonta (as at Franklin), Chadwick then gave a list of names applicable to successively later and more westerly formations that had all been confused together as "Catskill" in the literature of New York and Pennsylvania (pages 86 to 87), of which only five concern us now, namely:

- 5. Montrose (of Vanuxem; upper Chemung or Wellsburg);
- 4. Catawissa (lower Chemung or Cayuta);
- 3. Catskill proper (of Enfield or upper Portage age);
- [page 87] 2. Oneonta (of Ithaca or lower Portage age);
- 1. Kiskatom reds (of Hamilton age).

"Strictly speaking, the type Oneonta is only the upper Ithaca. . . . The original Catskill included 1 to 3, but in the later subdivision the Kiskatom was misidentified as Oneonta, while the term Catskill was restricted to 2 and 3, including thus the true Oneonta strata. To keep as close as may be to the intention of these writers, it is proposed to maintain the name Oneonta for all beds properly so correlated, meantime pushing the restricted term Catskill up to the still higher beds forming the peaks of all the true or eastern Catskills, whose age has been proved to be Enfield (upper Senecan)."

Convinced almost at once that this was not the proper solution of the nomenclature, Chadwick drew up a short supplementary note, offering two new names for numbers 2 and 3 of the above list, and submitted it in March 1933, to Science, but publication was denied for lack of space. Accordingly, the article was expanded, with a diagram added, and was accepted in April by the American Journal of Science but delayed until the November issue. In the interval, two other publications by Chadwick appeared, in one of which the new names (Onteora and Katsberg), first got into print.

But meantime, Dr Bradford Willard, also recognizing the inconsistency in the use of "Catskill proper" in the sense proposed

by Chadwick, called attention to this (1933, page 498) in these words: "By . . . substituting for Chadwick's restricted Catskill of Greene County an appropriate term for the red beds between the Oneonta and Catawissa (as Kaaterskill?), confusion may be avoided," and his paper was printed (in June) while Chadwick's new proposals were in proof, the charts with the names having been engraved. It is clear that, so far from being a formal introduction of the name "Kaaterskill" for these beds, this is a query, rather, whether that name will be "an appropriate term" for them. That such was actually Doctor Willard's intention was made perfectly clear by him in a letter to me dated July 29, 1933, in which he says: "I suggested 'Kaaterskill' in the hope that somebody personally familiar with the region would . . . propose a satisfactory name that would obviate duplication. Katsberg has my unqualified approval." More specific still is his confirmation of this in a letter dated February 26, 1935, stating: "As I wrote you (July 29, 1933), my use of the name Kaaterskill . . . was merely a suggestion with the implication that, if inapplicable, a better term should be suggested."

It happens, however, that Doctor Willard, having made only a brief visit to the Catskills and at a time when we were still following the old correlations and nomenclature on the Catskill front, had in mind a different set of strata, in the Kaaterskill clove, from those (actually some miles to the west) to which he thought the name might apply. The query as to appropriateness for the latter is thus answered in the negative. On the other hand, no other name could possibly be more appropriate for the great cliffs that rim the Kaaterskill clove and form both the Kaaterskill falls and the Haines falls on the Kaaters Kill, and that had impressed Doctor Willard on his visit. These are now believed to be referable to the Tully formation, being thus in need of a separate designation. In view of all these facts, Doctor Willard offers the following clarification and formal definition of his name:

"The name KAATERSKILL is proposed for red sandstones and shales now thought to be of Tully age which make up a portion of the original Catskill group of Mather in the Catskill Mountains of New York. Their type is the principal reddish and olive-gray sandstone ledges and associated red shales overlooking the Kaaterskill clove on the north and making the falls of the Kaaters Kill. Further field work may be necessary precisely to determine the stratigraphic boundaries of this member, which is a conspicuous element in the succession." (Bradford Willard, letter of March 4, 1935.)

It will be evident from the above that Dr Kenneth Edward Caster was not sufficiently informed when he said in 1934 (page 26) that "the type-section of Willard's Kaaterskill on Kaaterskill Clove appears to be in an exposure of Chadwick's Onteora red beds (Ithaca age)," and then continues "nevertheless Willard's name has priority," but does not tell us what name it has priority over—Katsberg or Onteora—in his opinion. Moreover, Doctor Willard has not previously specified a "type section," although naturally that would be in the Kaaterskill region, not elsewhere. He himself has used the name but once again, seemingly by inadvertence for Katsberg in a preliminary abstract of a paper for the Rochester meeting (1934, page 49), but not in the presentation of the paper at the meeting. These previous appearances of the name in print, arising from misunderstanding of the geographic relations and stratigraphic correlations, are therefore without prejudice to the name as now correctly defined and proposed herein by Doctor Willard. It is an appropriate and needed term that will have increasing usefulness.

In the International Congress guide book to the Catskill region, issued in April, 1933, Dr Marshall Kay and Chadwick used the name "Catskill red beds" for the Senecan portion only (page 4), exclusive of the Kiskatom; stating on page 6: "The Kiskatom formation includes the continental red and gray shales and sandstones that have been called Oneonta, [page 7] though they are considerably older than the typical Oneonta, which occurs farther west." The "succeeding Senecan Catskill formation" is then referred to Genesee and Portage age. The same distinction is made on later pages, and also in the block diagram, plate 1, though the Kiskatom is not carried far enough up the mountain by the artist nor given sufficient thickness.

In September, 1933, appeared the first instalment of Chadwick's revision of the Upper Devonian, in which (page 101) the mode of origin of the name "Catskill" was more accurately although still briefly presented, with recognition at last that Mather's final type-section was restricted to the lower beds and "actually covered little more than the part we now find to be of Mid-Devonic age (Hamilton), our Kiskatom formation." (Subsequent demonstration that the Tully too is Hamilton, has shown that Mather included Hamilton strata only.) In the chart on page 102, the name "Onteora" replaces that of "Oneonta" for the pre-Enfield beds of the Senecan (unfortunately and incorrectly made to include the Tully), and Katsberg that of "restricted Catskill" or "Catskill proper" for the Enfield portion. References in this chart and the text (page 103)

are to the expected but delayed article in the *American Journal*, in which these two names are properly defined (1933, pages 482 to 483). The entire latter article is a review of the history and scope of the name "Catskill," too lengthy to quote, and agreeing mostly with what has herein been told more fully.

The part of this article that is new is (page 482): ". . . the State survey adopted a subdivision of the eastern or type reds into an 'Oneonta' below (supposed Portage) and a restricted 'Catskill' above (supposed Chemung), . . . I therefore tried (1933) to maintain this usage with rectifications, but in view of the history just given that course now seems questionable. 'Catskill,' as so used, is not the [restricted] Catskill of Mather but far above it. Nor is it the Catskill of Vanuxem, which specifically included the Oneonta. In place of it I now propose the old Dutch name for these mountains miscalled 'Catskills' by the English (kill is creek), namely Katsberg (pronounced [page 483] cots-barrakh), for '3. Catskill proper' of my previous paper, to designate the Enfield reds. Since the downward extension of 'Oneonta' at the east to include also lower Ithaca (Otselic), Sherburne, Genesee and Tully equivalents is equally faulty [this statement itself is faulty since we know today that type Oneonta includes also Otselic, and that the Tully is Hamilton], I offer instead for these lower Senecan reds the aboriginal Indian name for our mountains, *Onteora* ('hills of the sky'), replacing '2. Oneonta.'

"The type section of the Katsberg formation will be taken in the steep slopes of the highest peak, Slide Mountain, exclusive of the capping Slide Mountain conglomerate (possibly of Chautauquan age [meaning Chemung, no longer Chautauquan]); that of the *Onteora* formation will be in the vicinity of Haines Falls, Greene County, New York, up the sides of the Kaaterskill 'High Peak' and 'Round Top' mountains where long ago measured by Sherwood. . . . Up the opposite slope is *Onteora* Park. The highest beds in Sherwood's section may be in the basal Katsberg (the Kattel shale horizon). His lowest thousand feet or so is the upper half of the Kiskatom. All the rest is *Onteora*." The section that follows on the correct usage of the name enumerates (page 483) four possible courses, the "most natural and familiar one" being to "let it cover all the red beds in the Catskill mountains proper," while the others are to restrict it to either the Upper Devonian (Senecan) portion of these "as in the Congress guide-book" or to the Hamilton portion (Kiskatom) "as Mather limited it," [page 484] which "would likely be an unacceptable plan," or, finally, and as "the least defensible course," to continue it broadly and loosely in a facies value only.

subserving current practice. This is the latest expression to date covering the subdivision and correlation of the Upper Devonian and Hamilton beds in the Catskill mountains. At the Chicago meeting (1933) Chadwick (page 18) dropped the Chemung down into the Senecan, equivalent to upper "Portage." Coincidentally, Cooper and J. Stewart Williams (page 20), described the passage of the Tully into red beds east of Schoharie valley.

Late in 1933 appeared Cooper's account of the Hamilton in eastern New York in which (page 537) his work was said to be "an attempt to carry the various stratigraphic units of the Unadilla Valley into the continental beds at the base of the Catskill Mountains." This work showed him (page 538) that "in Albany and Greene Counties practically the entire Hamilton above the Marcellus has passed over to continental beds," and his maps show this change, while his chart of sections on page 544 has "Red and Green beds" extending down to the top of the Marcellus (top of Cardiff) in his most easterly section, on the Berne and Durham quadrangles of Albany and Greene counties. For the representatives of the Tully and Sherburne in the Schoharie valley, here partly continental and partly marine, the new name "Gilboa" is used in this chart and is defined in the second part of Cooper's paper issued early in 1934 (page 7). Speaking of the area "a little west of Catskill village," in this second instalment, Cooper says (page 5): "The Ashokan division is followed by a great thickness of red beds, and intercalated greenish, cross-bedded sandstones, the Kiskatom beds of Chadwick, beautifully displayed along the highway up the Kaaterskill to Haines Falls and Tannersville. Much of this section undoubtedly belongs to the Hamilton and Gilboa . . . divisions."

Not having then made more than an incidental tracing of the supra-Hamilton strata, and being doubtless misled by Chadwick, Cooper still recognized a supposed lower Ithaca (Otselic) beneath the typical Oneonta, and associated the Tully with the Sherburne instead of with the Hamilton, though in conversation and correspondence he was inclined, like the writer, to be skeptical of this association.

Dr Hervey Woodburn Shimer's correlation charts, issued in 1934, show no impress of the newer discoveries except the comment (page 917): "The Catskill in the Hudson Valley extends down into the Hamilton."

The history closes, at the moment, with three papers by Chadwick, published in 1935. In the first of these, on the Pocono problem, the east-west age-relations of the various red-beds and "white" beds ("Pocono") are brought out in a generalized cross-section diagram

(page 134) from the Catskill mountains and the Pocono plateau westward to the Ohio line. Attention was called (page 138) to the fact that "Mather gave us a meticulously detailed and delimited section along a known highway for his Catskill," and further (page 140) that in the Catskills, "according to Lesley in the summary report [1892] . . . (page 1567), the Pocono (Lesley says) forms approximately the upper 1,000 feet of the peaks. Such a conglomerate indeed constitutes the thousand feet and more of the summit of Wittenberg, where it is best exposed, and others of the high central Catskills, but it is easy to show by direct tracing that this Wittenberg conglomerate is upper Enfield, equivalent to upper part of the Hatch shale of western New York, of Naples age. Above it, capping only the one highest pinnacle of the Catskills, is the thinner Slide Mountain conglomerate, corresponding apparently to the Grimes sandstone or basal bed of the Chemung, and thus perhaps to the base of the typical Pocono or lower. In the most easterly peaks of the Catskills, moreover, come in yet lower puddingstones, not much above the top of the Hamilton, . . . A series of carefully measured sections in the Catskills is about ready for publication."

On page 142, Chadwick makes the arresting assertion: "type Catskill is Hamilton."

The second paper by Chadwick, that on faunal differentiation, assigns the known "Catskill" fossils as follows, the Hamilton portion not being included in this assorting of the Upper Devonian faunules: To the Naples group (page 314) "the bulk of the Onteora (which includes a Sherburne equivalent at base) and the overlying Katsberg (Enfield equivalent)." In the Chemung group (page 318), followed easterly, "the Wellsburg becomes the Montrose red-beds, and the Cayuta the Catawissa reds." To the Canadaway group (page 323) the Mansfield iron-ores and the Blossburg red-beds and other strata; to the Conneaut group (page 326) a mass of unnamed continental strata to which it is now proposed to apply the name COTTON formation from Cotton creek in Bingham and Genesee townships, northern Potter county, Pennsylvania, since both of these township names have been preoccupied; to the Conewango group (page 329) the Cattaraugus beds. The most of the "Catskill" of Pennsylvania belongs to these last three groups, Canadaway, Conneaut and Conewango, which have no representation in the Catskill mountains and no right, either faunal or stratigraphic, to lay any claim to that name. The faunas of all these will be listed presently.

In this paper, Chadwick states (page 309) his reasons for restoring the Tully limestone to the Middle Devonian, as an upper member

of the Hamilton, a correction that would automatically extend the Kiskatom red-beds up to include the Tully reds, believed to be represented by the strata that Willard has herein designated, on a previous page, as the Kaaterskill sandstones and shales. But in the third of Chadwick's 1935 papers, namely that on the identification of the Chemung with the Portage, which had been intended to precede the faunal paper, Chadwick's figure 2 (page 347, reproduced with the corrections as figure 10 of this Bulletin) has not been properly corrected at this point in the extreme eastern section ("Catskill Mts."), so that the Tully still appears to form a basal part of the Oneonta red-beds. (On page 353, however, the Tully is not included in the Oneonta, in the table.) Cooper's names were unfortunately omitted from the Schoharie section, through failure to receive his paper in time. A more serious error, subsequently recognized, is the placing of the Otselic below the Oneonta in the Oneonta section, whereas simple inspection of the diagram shows that there the sub-Oneonta beds must be practically all Sherburne (Genesee) in age, although filled abundantly with the "Ithaca" fossils.

This correction had meantime been made in recoloring the Upper Devonian on the large relief map of New York State in the University of Rochester museum, in anticipation of the annual meeting of the Geological Society of America held there in Christmas week 1934. In the program abstracts for that meeting (page 11), Chadwick comments on how the map brings out "the downward extension of the red beds to the east into Middle Devonian strata," and adds: "The location of the type section of the original Catskill (practically all Hamilton) is shown, and the fallacy of extending this name to any beds later than Enfield in age is evident." It is true that the mere drawing of the formational boundary lines on this accurate relief surface did more than weeks of field work to simplify some of the problems and rectify minor errors such as that of the Ithaca-Sherburne line at Oneonta.

CLAIMED ABSENCE IN NEW YORK

There is one rather remarkable phase of this history to which special attention has not yet been directed, in this writing, and that now must be looked at. This is the far-flung and persistent rumor that "there is no Catskill in the Catskill mountains." In view of all that has been told in these pages, such a statement seems too ludicrous to answer. We have in the Catskills not far from a mile and a half of continental beds of "old red" type, unbroken by marine interfingerings from Catskill township to the highest summit, Slide

mountain, if it is the lithology that is questioned. We have Mather's elaborately recorded type section and full lithic and faunal descriptions, if it is definition that is questioned. For it should be noted that the shells and most of the plants figured by Mather do actually occur in the Kiskatom beds and have actually been collected from these beds by the writer on the very mountain face (see figure 6) where Mather's type section of his Catskill was measured. How, then, could such an idea gain credence?

An innocent remark of Colonel Jewett in his brief letter of September 1862, describing his visit to Mr Way at Franklin, is the start of the whole canard. Jewett wrote (page 198): "From my investigations, I believe there is no Old Red Sandstone in this State. I found no forms among the fish remains like those of the Old Red Sandstone of Great Britain, but we have plates far larger than those found there." By this, it is clear, that Jewett meant simply to question the correlation that had been made between the red Catskill rocks of New York and the Old Red Sandstone of Europe, perhaps also any association of the name Catskill with Hall's Old Red Sandstone of Blossburg. Jewett knew the Catskills, whose lofty peaks are in plain sight from his windows of the State Cabinet, too well to mean anything else. But when this letter was immediately reprinted in the *American Journal of Science*, it was made to close with these words (page 418): "From my investigations, I believe that there is no Old Red Sandstone [Catskill formation] in this State. * * *" This unwarranted interpolation, with suppression of the explanatory closing sentence, gave the world outside the impression that, as put by Williams in 1886 (page 229) Colonel Jewett had said there was "no Catskill whatever in the state." Prosser, for instance, in 1899 (page 118) quotes Jewett as having said "there is no old red sandstone (Catskill formation) in this state." The sin of misquotation shows its heinousness. Dr Edward Martin Kindle alone of subsequent writers had a correct conception when in 1896 he said (page 8): "The discovery in the year 1862 of fish bones of a characteristic Catskill species associated with Chemung fossils in the Catskill rocks created doubt as to the superior position of those deposits. Col. E. Jewett declared his belief that there 'is no Old Red sandstone in the State.' Prof. Hall was led by the same fact to modify his views of the extent of the Catskill group."

There is some reason to suspect, from Hall's writings, that he himself was at the bottom of the clamor that arose, out of which he garnered funds from the Legislature for an otherwise uninteresting

and unpopular investigation. In 1863, Winchell commented (page 61): "The announcement by Col. Jewett of the grounds of his disbelief in the existence of the Cattskill group, within the State of New York, is producing a sensation among geologists;" and he goes on to voice his own "disbelief of its existence as a distinct group," as also his "serious doubts about the Devonian character of the Old Red Sandstone of New York." Winchell's argument is not, however, that there is no Catskill in New York, but that the Catskill "does not in reality overlie the Chemung," with the implication, rather, that, being presumptively Devonian, it may underlie the Chemung, which he wishes to make "Carboniferous."

Referring in 1872 (page 10) to the work of "Dr. J. W. Hall and Mr. G. B. Simpson . . . in tracing the outcrop of this formation," the Oneonta, Hall says: "The difficulties attending the determination of the limits of . . . the Catskill group are still far from being resolved. The suggestion made by some geologists, that the formation probably does not exist within the limits of the State, has, however, been abundantly disproved." In spite of this assurance, Doctor Newberry, in his first volume of the Ohio reports (1873), has the following to say (page 71) under the heading of the "CATSKILL GROUP": "This group is known by the name of the Catskill formation, a name which it received when it was supposed to form a large part of the Catskill mountains. These are however now known to be composed mainly, perhaps exclusively, of older rocks. The Catskill formation is for the most part confined to Pennsylvania, scarcely reaching over the line into New York."

It must be admitted that Hall's statements in his annual reports, of which excerpts have been given in earlier pages, and particularly his first paper of 1862, gave some justification to outsiders for such assertions, for in declaring the Chemung age of large areas "colored as Catskill" on the maps, Hall neglected to make clear that the beds of whose Chemung age he was convinced were not marine, but continental and largely red, replacing the marine beds laterally, as seems unquestionably to have been his understanding of them. There is every chance that to one unfamiliar with the facts and with the geography Hall's words could mean that he had found the Catskills themselves occupied with marine beds of fossiliferous Chemung. Newberry's lack of information of the region is evident as he continues, immediately: "It is probable, however, that it [the Catskill as he understands it] once reached far north of its present limits. I have specimens of unmistakable Catskill sandstone,—differing lithologically from the Pennsylvania Catskill, but containing

the same fossils,—from Gilboa, New York.” Thus in the visible proof of red-beds at Gilboa, far to north and down in upper Hamilton, Newberry thought to see (in a desert of marine Chemung?) an outlying oasis of the post-Catskill (Blossburg etc.) red-beds of Pennsylvania, demonstrating the former great extent of continental strata now removed by erosion.

Quite different from this naïveté is Newberry’s informed statement in 1889 (page 106) that: “The Catskill formation took its name from the Catskill Mountains, which are in large part composed of it. It consists of a series of conglomerates, sandstones and shales, of which the prevailing color is red, . . . The area occupied by the formation is not large.”

In the long meantime, further light on the story had been shed by Hall. In 1876, referring to the results of the four years of work by the Sherwoods, Hall says (page 80): “The question had been raised regarding the existence of the Old Red Sandstone, or Catskill Group, [note that Hall himself is confusing the issue] within the limits of New York, although a considerable area had been thus colored on the original geological map of the State.

“The assertion of the non-existence of this formation in the State, had induced me many years since, to review some portions of my work of 1844, and while in the main features it was found correct, it became evident that something farther was needed in the elucidation of the structure of the Catskill region. In fact, it became evident that one could travel from Schoharie County to Pennsylvania line, on rocks of the Chemung group, without touching or seeing the Old Red Sandstone [this is not true]. And from this circumstance arose the statement of the absence of this formation from the State of New York. It became a very different matter, however, when one crossed the same region of country from east to west.” Knowing how this controversy was precipitated, and comparing this in turn with Hall’s statements of two years later, there is room here for thought, especially when Hall goes on (as quoted in previous pages) to speak of how, since 1857, “the question of the Geological Age of this great accumulation of strata . . . had never been lost sight of; though for many years it had been quite impossible for me to undertake the investigation.”? And further (page 81): “In 1870, when for the first time I was able to give attention to this part of the country, there was no definite knowledge of the region; the record of the Geological Map had been controverted, and a denial of the existence of the Catskill or Old Red Sandstone, within the State of New York, was the prevalent opinion.” Employment of the Sherwoods then followed, as has been related earlier.

Two years later, in 1878, before his own Albany Institute, Hall said (page 214): "At the close of the geological survey of the state, a certain area in Greene, Delaware, Ulster, etc., had been colored as covered by the Catskill group. Subsequently some question had arisen as to the true interpretation of the geology of the region; and while at that time he [Hall, the writer] was satisfied of the existence of the Catskill or old red sandstone in that district, it was nevertheless evident that something was required in the way of a reinvestigation. Five years ago the Regents of the University, recognizing this want, had authorized him to employ an assistant to work in this region;" and Sherwood had worked there for four years on the map exhibited.

"In the meantime," Hall continues, "since the completion of the geological survey [of 1836-1840], it had been published in the reports of the State Museum of Natural History and elsewhere, that no old red sandstone or rocks of the Catskill group really existed in the state of New York. In proof of this assertion, the testimony of some person had been given who had travelled from Franklin, in Delaware county, N. Y., [note the change in geography] to Port Deposit, in Pennsylvania, without meeting with these red rocks in the entire region traversed." His explanation of this is that "the road, as most of the other principal roads in the same direction, lay along the line of the eroded anticlinals which had brought up the rocks of the Chemung group; and it was not possible to see any old red sandstone without diverging to the right or left into and over a rough country having few or no roads."

Such a traveler must have been purblind, for Franklin lies on the Oneonta beds and all roads out of it (I have explored them all) have to cross these reds. But funds were sorely needed.

The "anticlinals," as already mentioned, have no existence. Hall continues: "Very recently it has been stated in a geological report of a neighboring state that it is now known that the Catskill mountains are of older rocks than the old red sandstone [turn to page 215] or Catskill group. But we have now conclusively proved that which had been known to a few persons for several years that while the base of the mountains [on the west side only had he such "proof"] consists of Chemung rocks, their greater portion is composed of rocks of the Catskill group;" overlain, he thinks, by "lower carboniferous formations."

A year later, 1879, Hall again says (page 13): "On several occasions questions had arisen regarding the existence of certain formations within the limits of the State; and in the report on the State Cabinet of 1862, the curator (E. Jewett) stated that from

the observations of himself and others, the Old Red sandstone, or the Catskill formation, did not occur within the State of New York." Thus is the misquotation perpetuated by Hall. He proceeds:

"A review of the ground during the following year (1863) convinced me that the observations on which this conclusion was based, had been conducted along the line of an eroded anticlinal valley; and that the red rock of the Catskill formation occupied the higher portions of the country on either side. Having made geological sections across this part of the country in 1844, I saw nothing on this review to conflict with the observations made at that time; but as the lines of section had been carried southward from the Mohawk, they had extended only to the higher portions of country in the range of the Catskills; and these elevated outcrops . . . proved to be, as I had before asserted [where?] synclinals, preserving the red shales and sandstones in their upper members." Hall's previous writings fail to sustain his growing claims that he had seen all these novelties as far back as 1844, or at least by 1863, nor the further claim made beyond (page 14) in this same report, that in 1857 he had learned all there was to know about the stratigraphy of the Catskill front, and "therefore . . . had sufficient evidence of the occurrence of old red sandstone in the Catskill mountain range." This is a report, be it remembered, intended for Legislative perusal. There is no known mention of "anticlinals and synclinals" by Hall until 1875, after the close of Sherwood's investigations; nothing whatever that will harmonize with such an interpretation in Hall's lengthy account in 1862 (not 1863) of the Franklin area which, after Jewett's visit, he says he had "since personally examined" and for which he publishes the elaborate measured section (pages 378 to 379) already quoted on page 45; no whisper that prior to 1862 he had known there are marine beds above the Oneonta reds in Delaware, Otsego and Chenango counties. Hall, at 68 years, was by no means childish (his active work continued until the day of his death, 19 years later), yet in the three years from 1876 to 1879 he seems to have come to appropriate all the findings of Sherwood and of Way and others, as his own work of many years before.

In 1880, on the claim that the previous structural work had not subdivided the "formation" [though a map had been exhibited in 1875], Hall says that "it was only in the present year, 1880, that Mr. Sherwood was again employed to complete investigation for a final geological map."

It seems safe, therefore, to suspect Hall himself as enjoying his little fiction that "there is no Catskill in the Catskill mountains."

A curious side issue of this became the further claim that the type section of the Catskill formation lay outside of New York State. The most outspoken assertion of this is by Stevenson, as late as 1893, when he dismisses Darton's excellent work by saying (page 332): "A lithologic distinction between Chemung and Catskill was not the basis on which the groups were separated in the typical locality of the latter, which is Susquehanna County of Pennsylvania, and no such distinction can be used with safety." And further (page 333): "That the Catskill Mountain region is not the typical area of the Catskill Group has been mentioned." This he explains thus: "Vanuxem used the term 'Catskill Group' in his final report to designate the summit rocks of the Devonian, the group to which he had given the name of Montrose sandstone in the fourth annual report. The distribution of the group as given in the final report differs little from that given in the annual report, but in the former [the final report, be it noted] the Oneonta sandstone is taken as the equivalent of the Montrose sandstone."

Since the Oneonta sandstone was mentioned by Vanuxem alongside of the Montrose from the beginning, since the "distribution of the group" always applied more specifically to the Oneonta than to the Montrose, and since Vanuxem's diagnostic fossil shell, *Archanodon catskillensis*, besides his plants, *Sigillaria simplicitas* and *Rhachiopteroides punctatus*, came from far northern localities, in the Oneonta and fully 2,000 feet below the Montrose, Stevenson is clearly wrong as to the facts. The involution in his reasoning comes out better in his paper of the preceding year, 1892, in which he says (page 23): "'Catskill Group' was first used by Vanuxem in . . . 1842, though he had previously fixed the lower limit as may be seen by reference to the fourth report, where he takes the Montrose sandstone as representing the group." Reference to the fourth report shows that Vanuxem said "Montrose sandstone, or sandstone of Oneonta," thus including the Oneonta from the beginning; and just how he could take anything "as representing" a group not yet named by Mather is difficult to grasp. Vanuxem says nothing whatever about correlation of his rocks with those of the Catskill plateau, which lay wholly outside his district.

Both of these papers of Stevenson, especially that of 1893, are examples of arm-chair geology. He persistently confounds the Montrose of White with the Montrose of Vanuxem. The later paper puts the Blossburg red-beds (which are post-Chemung, Canadaway) into the "Lower Chemung" (page 332), which, since Blossburg is west of Montrose, is in complete contradiction of his

own assertion (higher on same page) that the reds go lower to the east; and the remainder is unfortunately full of similar misinformation, even from the standpoint of the time when it was written, indicative of his unfamiliarity with the facts of the region. Difficult field problems cannot be thus settled *ex cathedra*.

The latest expression of such erroneous concepts is that of Willard in 1933, who (page 498) remarks: "Mather's original 'Catskill group' is now known to be nearly all Oneonta or older, so that the name Catskill is inapplicable at the type locality." Considering that the Oneonta was from the first regarded as an expression of the typical Catskill, and actually is the correlate of the portion of the red-beds that in the eastern Catskills came to be regarded by Hall and his successors at Albany as the Catskill *proprement dit*, and also that *Archæonodon catskillensis* of the Oneonta (as also of Mather's typical Catskill exposures) was accepted in the final reports as the diagnostic fossil of the group, in 1842 and 1843, this remark of Willard's might be looked upon as the final gasp in the attempt to kidnap the Catskill from its cradle in our mountains and raise it up as the foster child of Pennsylvania in a wholly new environment. But its justification is rather in Chadwick's mistaken effort in trying to keep the name Catskill above that of Oneonta stratigraphically, for the portion of the red-beds that he shortly afterward defined as the Katsberg.

Against all these denials of New York's legitimate claim to its own child we have the repeated testimony of Lesley—in 1875 (page 97; see 59): "The Old Red Sandstone . . . is well represented by a very thick formation . . . constituting ranges of mountains, such as . . . the Catskill Mountain, . . . The Old Red, or Red Catskill, . . . is between 1,000 and 2,000 feet thick where it outcrops . . . on the south flank of the Catskill Mountains in New York."—in 1878 (page 15): "the Catskill Mountain on the Hudson shows side walls of Red Catskill rocks, supporting peaks of the White Catskill."—in 1882 (page x): "The body of the Catskill plateau is composed of the . . . Catskill formation, . . . which is at least 5,000' thick."—and finally and unequivocally in his final report of 1892 (page 1567): "*The Catskill Formation*. This uppermost division of the Devonian system was named after the lofty mass of mountain land which rivets the admiring gaze of travellers on the Hudson river after they have passed the Highlands and are nearing Poughkeepsie, on their way to Albany." There is also the testimony of his assistants, Chance in 1880 (page 107): "the erosion limit of the Catskill formation . . . is along the northern face of the Catskill mountains, between the Hudson and Delaware rivers," and Ashburner in 1888 (page 954) who measured 2900 feet of

"Catskill red sandstone and shale" in his section from Slide mountain to the Mohawk, across the central Catskills, besides that of S. A. Miller in 1877 (page 15): "The shales and sandstones of the Catskill group form in their greatest expansion at the Catskill Mountains, from which the group takes its name, a mass of at least 3,000 feet in thickness," and that of Dana in 1880 (page 279): "The formation . . . thickens toward the Hudson, being two or three thousand feet thick in the Catskills," and in 1895 (page 604): "The Catskill group—so named from the Catskill mountains of eastern New York." We have also Newberry's: "The Catskill formation took its name from the Catskill Mountains, which are in large part composed of it" (1889, page 106) and Darton's: "The typical 'Catskill' region is of course the Catskill Mountains" (1893, page 208). Thus the integrity of the Catskill group in New York has always had its defenders outside the State as well as within.

To withdraw the name "Catskill" from its type area, because that has proved to be older than originally supposed, and to apply it to later rocks elsewhere that were mistaken for it, would be as unwarranted and indefensible as to continue using the name "Hudson River group" for the Lorraine and associated beds in central New York and the Ohio valley, while depriving the original strata on the Hudson of the name because they have proved to be pre-Lorraine and pre-Utica. It has somehow seemed easier for men to accept this correction of the use of "Hudson River beds" in fossiliferous and non-red formations than for them to relinquish their notion that in some obscure way the same rules of procedure are nonoperative for beds that are red. The situation has been well put by Williams (1903, page 44): "But the significance of the facts was obscured in that case by the fact that the Catskill . . . is distinguished by its red sedimentation, which, therefore, was easily discerned in the field by the stratigraphical geologist; but the fossil evidence . . . had not in his mind the distinct stratigraphical significance which he attached to the color ingredient in the Catskill. The evidence of the Catskill was clear, and if the fossils told another story, so much the worse for the fossils. This was his attitude."

What the twist would have been had our color vision emphasized some other, now invisible, color contrast in the outcrops, is a matter of curious speculation. Why should we not discriminate and define the parvafacies of the red-beds sedimentation with the same care that we do those of the Chemung or the Naples or the Genesee magnafacies, and similarly restrict those names, as formations, to their typical parvafacies? Are the red-beds outside the law because they are red?

ERRONEOUS STATEMENTS

Modern workers should maintain a high standard of accuracy, especially in reviewing the writings of others. At least, whatever they have to say will undoubtedly carry more weight with their contemporaries than do the voices of the past, and therefore can hardly pass uncorrected. In 1934, Caster gave (pages 25 to 26) as his interpretation of the facts the following inaccurate summary: "The terminology of this red and green facies has been much discussed of late as a stratigraphic problem, the facies nature of the formation being overlooked. It was suggested by G. H. Chadwick early in 1933 that the name 'Catskill' be restricted to a single red member of the total red bed development in the Catskill area. This on the basis of what he determined to be the original usage of the name 'Catskill'. Translated into present terminology, whereby it is recognized that the Catskill red beds are the continuously coeval eastern expression of other beds to [turning to page 26] the west, Chadwick proposed to limit the name Catskill to a single parvafacies of the red beds (of Enfield age). Such usage is hardly to be condoned because of the community of the understanding of the name Catskill as applicable to the whole red sequence. The terminology which Chadwick suggested for the red beds of the Catskill Mountain front was:" (here follows a rephrasing of the table of seven distinct Devonian continental deposits that have locally been called Catskill, with the names believed by Chadwick to be acceptable for them).

The striking error in the above is the localization by Caster of all seven of these divisions in "the Catskill Mountain front," to which only two of them reach. This marks a misreading of the words of Chadwick who (1933, page 86), having just mentioned that the correlations under consideration extended "from central Ohio to eastern New York," introduces his table with the words: "From west to east the reds ('Catskill') are of successively older age, thus:". Just why Caster felt it necessary to "translate" Chadwick's conclusions "into present terminology" is not clear, nor does his "translation" appear to contain anything that is not axiomatic, but it will be noted, first, that Chadwick explicitly states that his limitation of Catskill in this paper (from which he afterward receded, as has been explained) was not based on "the original usage," for he says (page 87): "The original Catskill included 1 to 3," and, further, that the "facies nature" of the problem had been the very thing that had been

most to the front in all the "late" discussions of the subject, emphatically placed there by Chadwick.

It is not the arguments of Caster, but only his inaccuracies of statement that concern us at the moment, such as in his footnote to this list: "the Cattaraugus beds do not truly belong in the Catskill formation of Chadwick," which is self-apparent since Chadwick's Catskill is 3 of the list and the Cattaraugus is 7; nor is Caster's implication here (his direct assertion on page 27: "The Catskill formation of Chadwick is a magnafacies") in any sense correct, for Chadwick stated emphatically (page 87): "It is clear, however, that this name Catskill can no longer properly be used for those red beds farther west in Pennsylvania and New York that are of later and various ages," just before which it was made clear that the Catskill peaks included only up to number 3, Catskill proper of this paper. And Caster himself had on the preceding page (26) correctly stated that Chadwick intended to so restrict the name, a suggestion he was unwilling to "condone." Used in a facies, not a formation, sense, "Catskill" appears always in quotation marks in Chadwick's papers. To the expression "Catskill magnafacies" there is absolutely no objection. To "Catskill formation" as a synonym for this magnafacies, or in any but a correctly limited sense based on the painstakingly defined type section and the typical region there is the same valid and ineludible objection that there always is to any slipshod and omnium gatherum methods in either stratigraphy or paleontology, and it was this purpose of Chadwick's publication that Caster's misstatement (in an otherwise meritorious work) tends to thwart.

There are inaccuracies also in Willard's paper of 1933, a part of which are due to his not having some of the rather rare old reports at hand. Willard says (page 496): "Mather's original 'Catskill Group' of the Catskill Mountains included everything between the base of the Carboniferous ('Pocono') and the base of the Marcellus." And (page 498): "Mather probably intended . . . to include all the Devonian red beds." The quotations I have given in the opening pages show that it was the "Catskill Mountain" of Mather that was so embracive, whereas his later "Catskill" was strictly limited. Moreover, Mather included not merely up to the Pocono base, but also explicitly that formation and the (supposed) Mauch Chunk; even (probably by a slip of the pen?) the Pottsville! The Pocono was by no means left out. Willard's reference here is wrongly to Mather's final report of 1843. Similarly, his reference to Williams, following, is to the wrong paper; and of course Willard

did not mean to say that the type Catskill is "partly older than the marine Devonian," which is doubtless a proof reader's slip for Upper Devonian. There is no indication in Williams' paper cited by Willard that Williams included Sherburne beds in his concept of Hamilton; indeed, he distinctly separates by number the "fauna intermediate between that of the Ithaca and the typical Hamilton" in Otsego county that we now know to be Sherburne in age.

There are some other slips, not affecting our problem, and one might differ from Willard as to the amount of credit to be given to Stevenson and Prosser or to Clarke's "Conceptions," or as to the inadequacies of Sherwood's Pennsylvania work, which in Bradford county seems to have been excellent as checked by my own considerable field work there. There is a phrasing (at bottom of page 497) that might be misconstrued, as to Williams' suggestion of inserting names for the "Catskill" parafacies, a difficulty that may be avoided by rewording this to read "by inserting, as Chadwick has since done, other names. . . ." Williams did not himself propose such names.

It may be well to explain that this paper of Willard's, as published, is not the paper that he says I read in manuscript, and that a large part of its contents I did not see until in print, although this is no discredit to the excellency of it.

S. A. Miller's statement in 1889 (page 65) that the Catskill was named by "Emmons" (who uses only "Old red sandstone") is of course a slip for either Vanuxem or Mather, probably the latter.

"CATSKILL" FOSSILS

The long current notion that the life of the Catskill was the same throughout all of the strata that have been assigned to that formation, in the loosest use of the name, will vanish before more extensive collecting and more precise identification of the fossils. Only five or six of the fishes, and one plant, are wide-ranging as now identified, in part dubiously. These are *Holoptychius americanus*, *Holonema rugosum*, *Ctenacanthus chemungensis*, *Dinichthys tuberculatus*, perhaps *Bothriolepis minor* and *Sauripterus taylori*, with *Archaeopteris minor*. And, of these, *Ctenacanthus* is not surely known from nonmarine beds, hence may be excluded from the count.

In considering these biotas, we may include as "Catskill" forms all fishes and invertebrate animals that have been reported from beds of continental facies, together with all known land plants from both marine and continental strata, since they could have grown only upon the land; and also land animals. Across New York and northern

Pennsylvania, the reported species are as follows, forms confined to any single list being italicized:

(0) *Hamilton group* (Kiskatom beds): *Archaeosigillaria* cf. *vanuxemi*, *Sigillaria?* *gilboensis*, *Protosalvinia huronensis*, *Archaeopteris hallana*, *A. minor*, *A. obtusa*, *Caulopteris lockwoodi* (equals one of the following), *Eospermatopteris textilis*, *E. erianus*, *Psilophyton princeps* (comes up from lower strata), *Rhachiopteroides punctatus*; *Archanodon catskillensis*, *Planolites clarkii*, *Beyrichia* 2 species, *Estheria membranacea*, *Bothriolepis minor?*, *Dinichthys* cf. *tuberculatus*, *Sauripterus taylori* (very doubtful), *Holoptychius americanus?*

(1) *Genesee group* (Onteora in part): *Archaeosigillaria primaeva*, *A.?* *gaspiana*, *Cyclostigma affine*, *Archaeocalamites inornatus*, *Protosalvinia huronensis*, *Archaeopteris jacksoni?*, *Cladoxylon mirabile*, *Psilophyton princeps*, *Rhachiopteris tenuistriata*, *Rhodea pinnata*, *Cordaites clarkii*, *Hormoxylon erianum* (or may be Hamilton); *Archanodon catskillensis*, *Holoptychius americanus*.

(2) *Naples group* (Oneonta and Katsberg): *Archaeosigillaria primaeva*, *A. vanuxemi*, *A.?* *gaspiana*, *A.?* *simplicitas*, *Protosalvinia huronensis*, *Archaeopteris jacksoni*, *A. hallana*, *A. obtusa*, *Asterochlaena noveboracensis* (possibly Genesee instead), *Eospermatopteris* sp., *Psilophyton princeps*, *P. robustum*, *Rhachiopteris* sp., *Rhachiopteroides punctatus*, *Cordaites clarkii*, *Hormoxylon erianum*; *Archanodon catskillensis*, *Estheria membranacea?*, *Stylonurus excelsior*, *Cephalaspis?* sp., *Bothriolepis nitida*, *B. minor*, *Onchus rectus*, *Dinichthys pustulosus*, *D. cf. curtus*, *D. cf. tuberculatus*, *Holonema rugosum*, *Sagenodus fleischeri*, *Holoptychius americanus*, *H. halli*. About one-third of these are not known in the higher groups.

(3) *Chemung group* (Catawissa, Montrose, type Pocono): *Archaeosigillaria?* *chemungensis*, *A.?* *corrugata*, *Archaeocalamites* sp., *Protosalvinia?* sp., *Archaeopteris rogersi*, *A. hallana*, *A. minor*, *A. obtusa*, *Callixylon* sp., *Rhachiopteris cyclopteroides*, *Rhachiopteroides pinnatus*, *Cordaites clarkii*, *Dictyocordaites lacoii*, *Taenioocrada lesquereuxi*, *T.?* *lineata*, *T.?* *chondriformis*; *Archanodon catskillensis*, *Stylonurus lacoanus*, *Bothriolepis minor*, *Stethacanthus tumidus* (or perhaps Canadaway), *Holonema rugosum*, *Holoptychius* sp., *Glyptopomus sayrii*, *Paramphibius didactylus*, *P. tridactylus*. Of these, *Archanodon* and *Protosalvinia*, with *Archaeopteris hallana* and *obtusa*, go no higher.

(4) *Canadaway group* (Mansfield, Blossburg and Tioga): *Protolepidodendron* sp. (possibly Conneaut); *Cephalaspis?* sp.

Bothriolepis nitida, *Gyracanthus sherwoodi*, *Holonema rugosum*, *Sagenodus fleischeri*, *Dipterus sherwoodi*, *D. contraversus*, *Ganorhynchus oblongus*, *Sauripterus taylori*, *Rhizodus* sp., *Holoptychius giganteus*, *H. americanus* ("nobilissimus"), *H. flabellatus*, *H. latus*, *H. serrulatus*, *H. radiatus*.

(5) *Conneaut group* (Cotton red-beds): Plants unidentified (see preceding list); *Gyracanthus sherwoodi*, *Holoptychius?* sp.

(6) *Conewango group* (Cattaraugus and Oswayo beds): *Archaeopteris roemeriana conferta*, *Trochophyllum breviinternodium*, *Lepidostrobis gallowayi*, *Psilophyton* sp., *Rhodea* sp.; *Eurypterus approximatus* (may be next group), *Bothriolepis minor?*, *Cladodus coniger*, *Helodus gibberulus* (may be next group), *Homacanthus acinaciformis*, *Ctenacanthus chemungensis?* (in marine beds, only, as low as Chemung, or lower), *Gyracanthus sherwoodi*, *Dinichthys tuberculatus*, *D. curtus?*, *Holonema rugosum*, *Sagenodus* sp., *Dipterus flabelliformis*, *D. nelsoni*, *D. minutus*, *D. alleganiensis*, *D. quadratus*, *Ganorhynchus beecheri*, *Apedodus priscus*, *Sauripterus taylori?*, *Holoptychius americanus*, *H. pustulosus*, *Rhadinichthys?* sp. nov. The most, if not all, of these Conewango fishes, occur in beds that are scarcely nonmarine, at Warren, Pa., and elsewhere although not far from the area of continental sediments of this group. Several of the species are found in distinctly marine beds at lower levels, but several are found in nonmarine beds lower down, also; the latter occurrences have, but the former have not, been listed in these lower groups. The unique and disputed footprint of *Thinopus antiquus* is in marine beds, possibly of a higher group.

No true "Catskill" facies is present in the Cussewago group, from which may have come *Thinopus antiquus*, *Helodus gibberulus* and *Eurypterus approximatus* (see preceding group for these), perhaps also *Stethacanthus tumidus*. Still higher, in the Shenango sandstone of the Waverly group (Mississippian) three species have been reported as "Catskill"—*Cladodus coniger*, *Ctenacanthus nodocostatus*, and *Stethacanthus depressus*. Of one other species, *Sagenodus angustus*, the locality and horizon seem to be unknown.

It would appear from these lists that there is quite as much distinction from one another in the successive land faunas, and in the floras, of the continental sediments, as in the corresponding marine faunas of these different groups of beds. Nevertheless, an almost untouched field awaits the collector, alike in the lower groups at the east and in the higher ones farther west.

SUMMARY AND INTERPRETATION

It is evident that Catskill, as applied to a geological formation, originated with Mather and was a contraction in form from his "Catskill Mountain" group of 1840 at the same time that the contents of the group were likewise contracted by exclusion of the non-red members at the base as well as by miscorrelation of the higher portions with Carboniferous rocks. It did not originate with Vanuxem, who had introduced his own names, Montrose or Oneonta, also in 1840, and who, according to Hall (1873, page 7), was induced in conference (Hall 1893, page 33) to set these aside and accept Mather's proposal. It must be remembered that Hall was one of these four geologists and, having been present at their conference, spoke from his own personal recollection. As I have noted elsewhere, it was because Vanuxem kept his final report down to about half the size of Mather's, and submitted it without colored plates while Mather's had profuse illustration, that his report came off the press in the year (1842) preceding Mather's. By this circumstance only did Vanuxem gain "priority" for a name agreed upon by all four men in advance, though neither Hall nor Emmons adopted it until some years later.

It may be well, therefore, to see how any "priority" claims set up here will affect other well-known New York formation names. Three of these other formation names were first published in 1842 by both Emmons and Vanuxem. It is believed that Emmons' final report came off the press in advance of that of Vanuxem. Shall Niagara limestone, Genesee slate and Erie group, in Emmons' table on page 429, have their type sections, therefore, in some unknown spot in his district of northern New York, where not one of them exists? Or shall their introduction be credited to Vanuxem, who says (page 90) of the Niagara group that "it first appears in Steele's creek southwest of . . . the village of Mohawk in Herkimer county" which is the most easterly known exposure referred to the Lockport; of the Genesee "slate" (page 168) that "it is a thick rock towards Cayuga lake" without a mention of the Genesee river; of the Erie division (page 16) that "it covers the whole surface south of the . . . Helderberg division, with the exceptions of portions of the counties of Otsego, Chenango, Broome and Tioga, which contains the Catskill group," and says not a word of Lake Erie? Are these the respective type localities?

What of the "Hudson River slate" first published by Emmons in 1841 (page 130) with the statement (definition?): "In the upper

portion of the same series of rocks [Mohawk limestone, etc.], but in the vicinity of Essex, a very good flagging stone also occurs. It is in fact the Hudson river slate, and forms the shores of the lake [Champlain] for a considerable distance"? Or of the Medina sandstone, of which the first publication is Vanuxem's in 1840 (page 374) with the definition: "Called in former reports the red sandstone of Oswego. This rock is confined to Oswego county, to the high grounds of Oneida at Florence village, and other parts of the town of Florence, and to the extreme north parts of the counties of Onondaga and Cayuga"? Here we have an exactly parallel case to the shift from Montrose or Oneonta sandstone to Catskill, and by the same writer. If the type section of the Catskill is either Susquehanna county, Pennsylvania, or else Otsego county, New York, both of them outside of the Catskills, then even more surely the type section of the Medina sandstone is on the Oswego river at Fulton, 100 miles east of Medina. How absurd.

Or what shall we do about Vanuxem's "prior" publication of Schoharie layers in 1840 (page 378), where he says: "These layers, I have not yet seen in the district"?

Perhaps these illustrations may suffice to exhibit the fallacy, but nevertheless if still, in order to satisfy legalistic minds, it is necessary to do so as a means of establishing Mather's property rights to his own name, Catskill, we may, fortunately, point to the fact that already in 1841 he was on the point of shifting to this shorter form, from "Catskill Mountain," because he did actually use "Catskill Series" once (page 81) in that report. Furthermore, if Catskill be ascribed to Vanuxem, then it was preoccupied by that same writer for a much lower formation, the Catskill shaly limestone of the Helderberg group, unless we disregard definition by synonymy on pages 6 and 12 of his final report (1842) and consider that page 16 carries the first formal definition of the term, here used for the higher formation with direct reference to the "Catskill mountain range" that lay outside of Vanuxem's district, and with no mention of his Montrose or Oneonta sandstones. That (legalistically) would seem to leave the name in about the same circumstance as if Mather himself had spoken, as a name based upon the rocks in the Catskills, from which alone such a name can be derived, not on something remote in Pennsylvania, nor even something on the Susquehanna at Oneonta, out of sight even of the Catskill peaks. Vanuxem himself says (page 16) that it was "founded upon an important geographical character."

It may be noted in passing that Merrill in 1902 (historic table opposite page 34) puts Mather's final report before that of Vanuxem, as if to accord Mather the priority, although his reason for so doing is not evident.

But when we have thus restored "Catskill group" to Mather, as of 1841, and to the Catskill region for its cradle, our troubles have but begun.

For Mather, after having defined his group in 1843 as the "upper members of the Catskill mountain series" of the previous reports, which went to the base of the "coal bearing rocks of Carbondale," and as including not merely Nos. 9, 10 and 11 of the Pennsylvania reports but also now their No. 12 (the Pottsville), and as occupying the counties of Delaware and parts of Sullivan, Ulster, Greene, Schoharie and Albany, or the elevated land called the Catskill mountains, besides that on the map only the Catskill color is spread over this mountain area with nothing higher mentioned or mapped, seems almost at the last minute to have changed his mind and stopped his Catskill division (in his elaborately detailed type section) at the base of the puddingstone ledge above the Catskill Mountain House and called all the beds from this ledge upward by a name that means to us today the Carboniferous proper or Pennsylvanian. In short, he thought this puddingstone ledge here marked the incoming of the Pottsville conglomerate, No. 12 of the Pennsylvania geologists.

Actually, this puddingstone is, approximately at least, the base of the Upper Devonian, so that by this upward limitation of the type section the "Catskill division" would be practically Hamilton rocks, Middle Devonian, only. Did Mather, in spite of all his descriptions and mapping, intend so to limit the "Catskill group," or does his inclusion now of "No. 12" (the Pottsville) in his synonyms mean that on the contrary he would expand his conception of the Catskill (as a group) to include, not exclude, these rocks that he mistook for Pottsville? Certainly he could hardly have thought of South Mountain, 2450 feet above tide, as one of those "high peaks" (Slide is 4205 feet) on which only, he says, are found the conglomerates and coarse grits underlying the coal beds, in small outliers. The map seems to contradict him. Nor do his colleagues seem at the time to have so understood. Apparently the name "Catskill" by general consent still embraced all the rocks of the Catskill mountains, the one possible exception being the strictly non-red Slide Mountain conglomerate at top.

Indicative of this consensus we have Stevenson's statement in 1892 (page 23) that "the whole mass in the Catskills proper has been taken

as belonging to the group," the rest of his sentence having no bearing on the question of the upward limits, and Darton's explicit comment in 1893 (page 208): "The typical 'Catskill' region is of course the Catskill Mountains and in this region the name was intended to comprise all of the great mass of gray sandstones and red shales up to the base of the doubtful conglomerate capping the higher summits." Certainly South mountain is not one of those "higher summits," while the conglomerate that Darton means is, as clearly shown in his figure 1 (page 204), nothing but that on the summit of Slide mountain.

Considering the upper limit in the "high peaks of the Catskill mountains," then, the formation goes as high as the base of the Slide Mountain conglomerate, which we take to be the base of the Chemung. Considering the original scope of the "upper members of the Catskill mountain series," at Carbondale, it goes to the top of the Chemung (locally the Pocono sandstones) or at least not higher. Considering the mapping of all of Delaware county and the Catskill outskirts as comprehended within the Catskill group of rocks, it goes at least part way up in the lower Chemung (Catawissa red-beds). Its downward limit in the type section is precise, namely the base of the Kiskatom reds near the Kiskatom old Dutch church.

Thus the "original Catskill" is either all Hamilton, Middle Devonian, and has priority over Chadwick's "Kiskatom," or it is this plus all or much of the Senecan reds of the Upper Devonian. No higher, post-Chemung strata, of the Chautauquan or Bradfordian, are included in it, in any case. Faunally, as well as stratigraphically, the latter are distinct, today easily distinguishable across southern New York and northern Pennsylvania. To the name "Catskill" they have no rightful claim. To that of "Hampshire," proposed for post-Chemung red-beds, they appear to be clearly entitled, if a single inclusive name is needed for them to take the place of Catskill. Otherwise they are identifiable as Blossburg, Cotton, Potter (of K. E. Caster 1934) and Cattaraugus, or other such local appellations as may be found useful. But they are not Catskill. Indeed, few of them, though partly "red," are even truly of "Catskill facies."

Some or all, then, of five recently named or renamed red formations, included within the scope of the "Catskill mountain series," are candidates for the election to the office of the Catskill formation as henceforth officially recognized. These five are the Kiskatom, Onteora, Katsberg, Catawissa and Montrose. The Kiskatom, the Catskill division of Mather's type section, is limited in distribution to the Hudson valley. It is Middle Devonian. It is

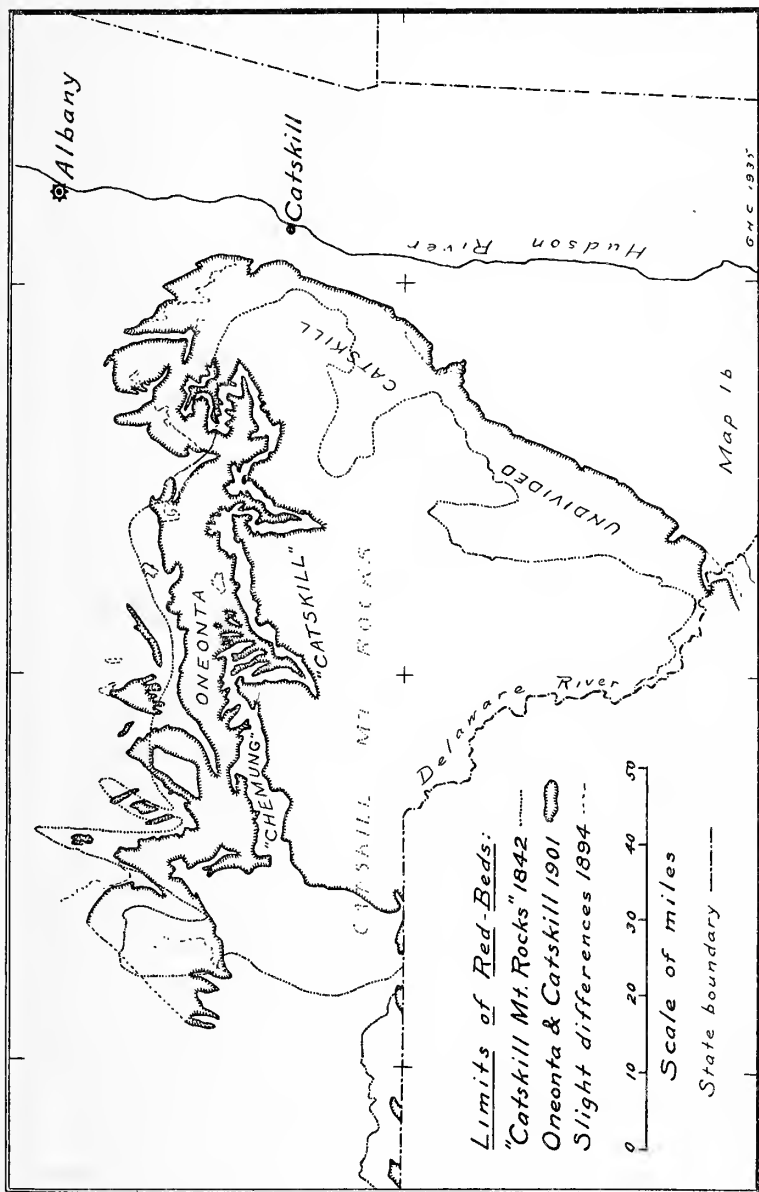


Figure 9 Same area as figures 1, 2 and 3, showing by dotted line the outline of the "Catskill Mt. Rocks" on the map of 1842, 1844; and in shaded line the distribution of the red-beds (Oneonta and Catskill) on the maps of 1894, 1901. In broken line are some small differences in 1894 map. All maps adapted to present base (figure 1).

Comparison with figure 3 shows that practically all of the Hamilton (Kiskatom) red-beds was excluded from the 1842-1844 map.

in these beds that the section lies at Post's mills to which the name "Catskill" as such was first applied. Shall we include, or reject it? The Onteora and Katsberg make up the bulk of the Catskill massif, all but the (largely subsurface) pediment and the tiny capping on Slide mountain. They stand or fall together. Shall we follow Mather's map and include them, or follow his type section and shut them out? Within the area of Delaware county, mapped as Catskill, are also beds of Catawissa reds. Do they go in, or out? And the Montrose, not alone of Vanuxem's Catskill but also the highest of those "upper members" of Mather, as represented south-eastward in the typical Pocono of Pennsylvania; what shall the verdict be? Vanuxem's Oneonta is a part of the Onteora. His Catskill is therefore of Naples and Chemung age, practically the entire Senecan. Mather's Catskill in the broadest sense is Hamilton (exclusive of Marcellus and probably some Skaneateles), Genesee, Naples and Chemung—all the Senecan and a part of the Erian, thus all of Vanuxem's Catskill and more. In the narrowest sense it includes none of Vanuxem's Catskill.

The diagnostic fossil, *Archanodon catskillensis*, begins its appearance in the Kiskatom and has been collected by me as high as the Montrose beds of southern Bradford county, Pennsylvania, but is unknown from any higher rocks. Its range is that of the Catskill of Mather in its broadest sense.

Inclusion of the Pocono or "White Catskill" by Mather and his successors until 1878, with its subsequent separation from the "Red Catskill" by the Pennsylvania survey under the mistaken belief that it was equivalent to Mississippian marine members in western Pennsylvania, has only this bearing on the problem, that in as much as the Pocono is merely a facies of the Chemung (largely of the Montrose member?) its original inclusion in the Catskill was highly proper. Early but erroneous identifications of the Pocono in the higher Catskills were therefore in no sense prescriptive, while all subsequent writings that have proposed so to limit the Catskill upward against such supposed Pocono are ineffectual, and would be, even if true Pocono strata were present there. For the western extension of the Pocono is the red Montrose (and some Catawissa reds?), which will certainly still be claimed as Catskill by the Pennsylvania geologists—a claim it would be difficult to gainsay. It seems therefore inevitable that the summit of the Catskill must remain at the summit of the Chemung, which is the summit also of the Senecan, as well as of the Montrose and of the Pocono.

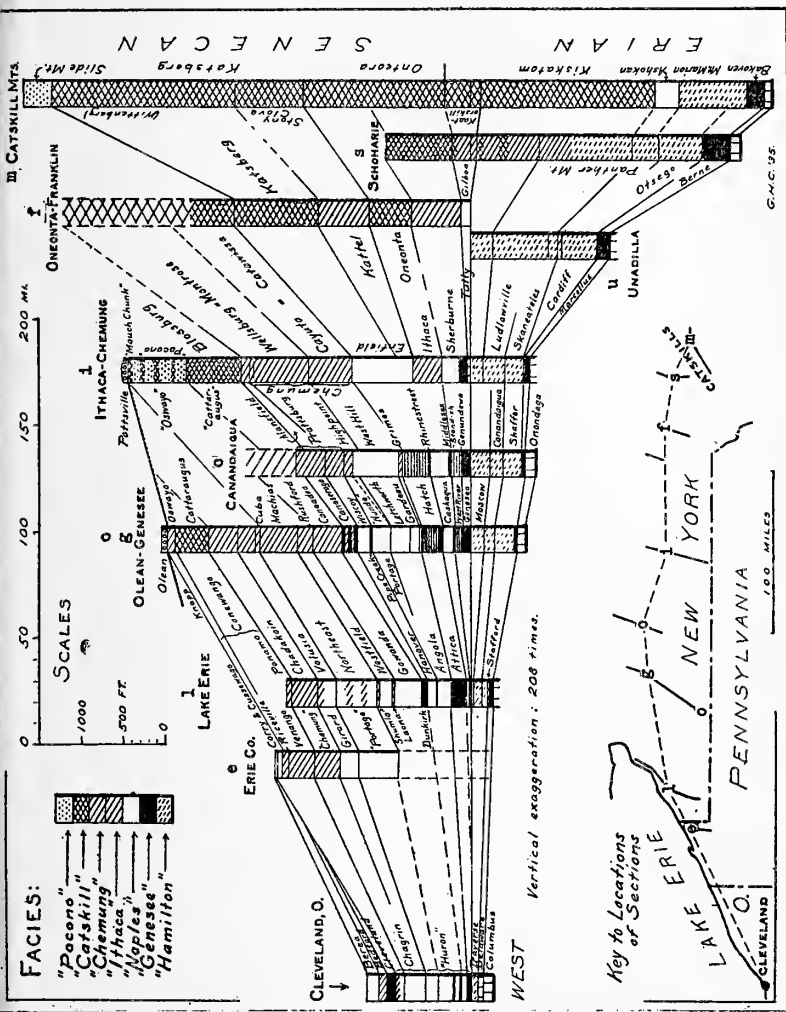


Figure 10 Correlation chart of Catskill and higher so-called "Catskill" red-beds from Catskill, New York, to Cleveland, Ohio. Reproduced with corrections from the Bulletin of the Geological Society of America, volume 46, page 347. The red sediments are cross-hatched. As originally used, the Catskill group included to the top of the Oneonta-Franklin Column or all of the Senecan red-beds plus the Kiskatom below. It is proposed henceforth to exclude the Kiskatom or Erian reds.

The first proposal to raise the lower limit of the Catskill in the type area was that of Hall in 1862, who wished to transfer to the Chemung everything beneath the Pocono. But in 1863 Hall made it clear that what he meant by this "Pocono" was the puddingstone just above the Mountain House, and that what he was really thinking of as "Catskill" was something that, like the Blossburg with which he was familiar, must be above the "Chemung." So far as the east face of the Catskills was concerned, this proposal amounted to having the Catskill begin just where Mather in the limited conception would have had it end. It gained in cogency through the years by the perpetuation through repeated field work of the fallacy that the Kiskatom beds are Oneonta, which, on the northwestern outskirts of the Catskills, the true Catskill was supposed to lie (some distance) above. Less than three years have elapsed since we first learned that the real Oneonta is high up on our eastern summits, although not as high at top as the Stony Clove flagstones which Darton included in it in Ulster county.

It is embarrassing to have any formation name lap across a subperiod line, such as that between Middle and Upper Devonian. To avoid it in this case we have the choice of limiting the Catskill to the Kiskatom, following Mather's last minute action, or of excluding the Kiskatom and making the Catskill coterminous with the Senecan. The former choice would restrict the outcrop to a small area in the Hudson valley only, extending but part way up the plateau wall, leaving only the modern variants, Onteora and Katsberg (both of which are translations), for the main mass of these continental deposits over several counties of New York, and many more counties in Pennsylvania, in fact for practically all of the country that is the Catskill mountains in the minds of men. The latter choice (which comes close to Darton's proposal of 1893) would retain Catskill group) for all this territory, whereas the exclusion of the Kiskatom would be a minor matter affecting only a small area in New York State, a matter in which individual judgment might vary a little without serious discomfort to the science.

In so applying the name Catskill group to the Senecan red-beds only, we would not only be in accord with Emmons' (1846) understanding of the Catskill as beginning with the Genesee but also be following Hall's (the first) restriction of the term in the Catskill front, stated in clear language (1863) and subsequently gaining status with every important pronouncement of the New York State survey, mistaken though their reasons were. (See also pages 37, 41 and 48 of this Bulletin.) The alternative appears to be to con-

tinue the straddle and retain both Erian and Senecan reds in the Catskill. In the forthcoming bulletin it is proposed to adopt the former course, keeping the Kiskatom distinct, in order to emphasize its Middle Devonian (Hamilton) age.

DEFINITION

In view of the original and concurrent intention of the members of the New York Geological Survey of 1836 to 1843, the upper limit of the Catskill red-beds is drawn at the top of the Montrose red-beds (of Vanuxem) of upper Chemung age, thus at the top of what we now understand as the Senecan series of the Upper Devonian, inclusive of the Pocono beds of the Pocono plateau. Although its original lower limit embraced the Kiskatom red-beds of Middle Devonian (Hamilton or Erian) age, to which portion Mather's final "type section" (1843) was confined by him through misidentification of the overlying conglomerate, yet as Mather's own map of 1842 (see figure 10) practically shut out the Hamilton reds, it is proposed that these Kiskatom beds, of small territorial extent, be excluded from the definition of the Catskill in accordance with the later interpretations of Emmons (1846) and Hall (1863 to 1893) and of the New York State Museum generally, thus making the Catskill a formational unit exactly correlating with the Senecan and expressive of the continental sedimentation of that epoch, alone.

BIBLIOGRAPHY

The following list is intended to include all the works or papers in which is to be found matter bearing upon the use, history and limitations of the name "Catskill" in stratigraphic geology, as affects its home region in the Catskill mountains or the efforts to appropriate it in other values elsewhere, together with such subdivisions as have been proposed within that home area. If any such publication has inadvertently failed of inclusion, a service will be rendered by calling the author's attention to the omission. In order to follow the text, in which the matter is arranged historically and the references are by year of printing, the list is made chronologic, the author's full name being given under the first date in which it occurs.

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- 1840 **Mather, William Williams.** Fourth annual report of the first geological district. N. Y. State Geol. Survey, 4th Ann. Rep't: 209-58
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Note: (See page 33, last line). Ashburner in 1877 (American Philosophical Society, Proceedings, volume 16: page 533) said: "As IX and X together make up the mass of the Catskill Mountains."

(See page 37, third line). In 1915 (New York State Museum, Bulletin 177: pages 155-56), Clarke was more guarded, saying: "The geological age of the Catskill formation in the Appalachian region . . . has been . . . regarded as covering the final term of Devonian time, and there has been no conclusive evidence adduced as yet that this terrestrial sedimentation ignored the . . . boundaries between the Devonian and the Carbonic. The writer has at one time or another expressed the belief that, so far as the Catskills of New York are concerned, a coordination of deposits of this "Old Red" type would indicate . . . that the Devonian-Carbonic . . . boundary line was actually transgressed . . . and that the upper part of the original Catskill sedimentation . . . , whether or not any trace of it remains from the subsequent dissection of the Catskill plateau, was deposited in post-Devonian times." This he argues from the (supposed) Carbonic age of the Cattaraugus beds, and by analogy with the Bonaventure conglomerate of eastern Canada.

INDEX

A. The Formations:*

- Angola**, 99
Ashokan, 8, 10, 11, 48, 58, 59, 70, 77, 99
Attica, 99
Bakoven, 11, 58, 59, 99
Bedford, 99
Berea, 99
Berne, 99
Blossburg, 23, 24, 36, 38, 40, 48-50, (55), 58, 59, 72, 78, (80), 82, 85, 91, 96, 99, 100
Bonaventure, 107
Bradfordian, 33, 96
Canadaway, 78, 85, 91
Canandaigua, 99
Canaseraga, 99
Caneadea, 99
Carbonic, 36, 37, 58, 107
Carboniferous, 5, 22, 23, 34-36, 38, 44, 49, 58, 62, 81, 89, 93, 95; *see also* Lower Carboniferous
Cardiff, 77, 99
Cashaqua, 99
Catawissa, 9, 11, 29, 32, 39, 58, 59, 72-74, 78, 91, 96, 98, 99
Catskill, 4-9, 16-17, 20-45, 47-63, 65-90, 92-101, 107; defined, 101; *see also* Gray Catskill; White Catskill
Catskill Mountain, 7, 8, 10-13, 21-24, 26, 29-31, 35, 36, 44, 49, 53, 58, 59, 89, 93-97
Catskill shaly, (27), 28, 29, 94
Cattaraugus, 36, 58, 69, 78, 89, 92, 96, 99, 107
Cayuta, 9, 25, 40, 58, 59, 72, 73, 78, 99
Cazenovia, 59
Chadakoin, 99
Chagrin, 99
Champlain, 38
Chautauquan, 33, 58, 67, 76, 96
Chemung, 5-7, 9, 11, 12, 23-26, 31, 32, 37, 40-73, 76-83, 85, 87, 91, 96-101
Chittenango, 58
Cleveland, 99
Coal, 7, 11, 12, 21, 31-33, 35, 38, 50, 58, 59, 95
Columbus, 99
Conewango, 78, 92, 99
Conneaut, 78, 92
Corniferous, 11, 58-61; *see also* Onondaga
Corry, 99
Cotton, 78, 92, 96; defined, 78
Cuba, 99
Cussewago, 92, 99
Danby, 58
Delaware, 99
Delthyris shaly, 28
Devonian (Devonic), 23, 24, 34, 36, 37, 42, 43, 48-50, 58, 62, 69-71, 81, 85, 86, 88-90, 107; *see also* Lower Devonian, Middle Devonian, Upper Devonian
Drift, 33
Dunkirk, 99
Enfield, 9, 25, 39, 45, 54, 58, 59, 64, 69, 71, 73, 75, 76, 78, 79, 88, 99
Erian (Erie), 11, 22, 31, 32, 37, 40, 41, 58, 59, 93, 98, 99, 101
Gardeau, 99
Genesee, 11, 25, 32, 37, 38, 41, 48, 55, 58, 59, 64, 68, 72, 75, 76, 79, 87, 91, 93, 98-100
Geneseo, 99
Genundewa, 99
Gilboa, 8, 77, 99
Girard, 99
Gowanda, 99
Gray Catskill, 34, 58
Grimes, 78, 99
Hamilton, 5, 9, 11, 13, 20, 27, 29, 32, 38, 41-50, 53-73, 75-79, 82, 90, 91, 95, 96, 98, 99, 101
Hampshire, 96
Hanover, 99
Hatch, 78, 99
Helderberg, 7, 8, 11-13, 20, 22, 93, 94; *see also* Upper Helderberg
Highpoint, 99

*Maps showing type localities also indexed.

- Hinsdale, 36
 Hudson River, 8, 87, 93, 94
 Huron, 99
- Ithaca**, 9, 13, 20, 25, 40, 41, 43, 51, 58-61, 64-69, 71-73, 75-77, 79, 90, 99
- Kaaterskill**, 8, 10, 58, 59, 74, 75, 79, 99; defined, 74
- Katsberg, 9-11, 29, 32, 55, 58, 59, 66, 73-76, 78, 86, 91, 96, 98-100
- Kattel, 9, 32, 45, 47, 54, 58, 59, 65, 66, 69, 76, 99
- Kiskatom, 9-11, 17, 27, 32, 38, 39, 48, 58, 59, 65, 66, 71-73, 75-77, 79, 80, 91, 96, 98-101
- Knapp, 99
- Laona**, 99
- Laurens, 4, 59
- Letchworth, 99
- Lockport, 93
- Lorraine, 87
- Lower Carboniferous, 36, 55, 58, 65, 83
- Lower Devonian, 27, 29
- Ludlowville, 27, 58, 71, 99
- Machias**, 99
- Mansfield, 78, 91, 99
- Marcellus, 13, 20, 22, 31, 43, 55, 58, 59, 71, 77, 89, 98, 99
- Mauch Chunk, 11, 34-36, 58, 89, 99
- Medial Silurian, 22
- Medina, 94
- Middle Devonian (Mid-Devonic), 11, 32, 65, 67, 71, 73, 75, 78, 79, 95, 96, 100, 101
- Middlesex, 99
- Mississippian (Postdevonic), 36, 37, 58, 69, 98
- Mohawk, 94
- Montrose, 8, 9, 11, 12, 25-30, 40, 47, 49-51, 58, 59, 63, 72, 73, 78, 85, 91, 93, 94, 96, 98, 99, 101
- Moscow, 42, 58, 59, 65, 71, 99
- Mount Marion, 8, 10, 11, 58, 59, 70, 99
- Naples**, 11, 58, 59, 78, 87, 91, 98, 99
- New Milford, 59
- New Red, 38
- New Scotland, 27
- New York (system) 24, 28, 29, 43, 55
- Niagara, 93
- Northeast, 99
- Nunda, 99
- Old Red**, 5, 6, 21-24, 28, 29, 31, 33, 37, 38, 40-44, 47-49, 51, 55-59, 79-84, 86, 90, 107
- Olean, 99
- Oneonta, 8, 9, 25-30, 39-43, 45, 47-51, 54-77, 79, 81, 83-86, 91, 93, 94, 97-100
- "Oneota," 62
- Onondaga, 9, 11, 40, 53, 58, 59, 99
- Onteora, 9-11, 32, 58, 59, 73, 75, 76, 78, 79, 91, 96, 98-100
- Oriskany, 61
- Oswayo, 92, 99
- Oswego (red), 94
- Otsego, 4, 8, 99
- Otselic, 8, 9, 40, 58, 59, 72, 76, 77, 79
- Paleozoic**, 33, 67
- Panama, 99
- Panther Mountain, 59, 99
- Pennine, 62
- Pennsylvania, 95
- Pipe Creek, 99
- Pocono, 11, 22, 33-37, 48, 51, 58, 66, 71, 77, 78, 89, 91, 96, 98-101
- Ponent, 44
- Portage, 22, 23, 37, 41, 44, 46-50, 52-61, 63, 67-73, 75-77, 79, 99
- Portland Point, 71; (P, 58)
- Postdevonic (Mississippian), 36, 37, 69, 107
- Potter, 96
- Pottsville, 11, 30, 32, 34-36, 40, 58, 62, 89, 95, 99
- Prattsburg, 99
- Red sandstone**, 21, 58
- Rhinestreet, 99
- Riceville, 99
- Rushford, 99
- Salamanca**, 36
- Schoharie, 8, 94
- Scutella, 28
- Senecan, 11, 22, 29, 32, 37, 38, 40, 48, 58, 67, 73, 75-77, 96, 98-101
- Shaffer, 99
- Shenango, 92

Sherburne, 4, 9, 13, 32, 38-40, 58, 59,
65-68, 70, 76-79, 90, 99
Shumla, 99
Silurian, 24, 43; *see also* Medial Silur-
ian
Skaneateles, 58, 59, 71, 98, 99
Slide Mountain, 8, 10, 39, 58, 59, 66,
67, 76, 78, 95, 96, (98), 99
Stafford, 99
Standish, 99
Starucca, 8, 51, 59
Stony Clove, 8, 10, 32, 39, 58, 59, 66,
70, 99, 100
Subcarboniferous, 34, 58
Tertiary, 7, 33
Tioga, 91
Traverse, 99
Triassic, 38
Tully, 11, 32, 37, 41, 43, 58, 59, 65,
68, 74-79, 99
Umbral, 35, 36, 58
Unadilla, 4, 8, 59
Upper Devonian, 5, 6, 11, 29, 32, 38,
42, 53, 62, 65, 67, 70-73, 75-79, 90,
95, 96, 100, 101
Upper Helderberg, 11, 40, 58, 59
Utica, 87
Van Etten, 58
Venango, 99
Vespertine, 11, 33-37, 52, 58
Volusia, 99
Waverlian (Waverly), 33, 92
Wellsburg, 25, 26, 58, 59, 73, 78, 99
West Hill, 99
West River, 99
Westfield, 99
White Catskill, 11, 33, 34, 58, (77),
86, 98
Wiscony, 99
Wittenberg, 8, 39, 58, 59, 66, 78, 99
VII, 53
VIII, 7, 53, 58
IX (No. 9), 7, 22, 29, 34, 36, 44, 47,
51, 53, 58-61, 95, 107
X (No. 10), 7, 11, 22, 29, 33, 34,
36, 47, 51, 58, 59, 95, 107
XI (No. 11), 7, 11, 29, 36, 47, 58, 59,
95
XII (No. 12), 29, 30, 32, 34, 47, 58,
95

B. The Fossils:**

Amnigenia catskillensis, 42, 56; *see*
also Archanodon
Apedodus priscus, 92
Archanodon, 42
catskillensis, (26), 42, (43), (54),
54, 56, 85, 86, 91, 98
Archaeocalamites, 91
inornatus, 91
Archaeopteris hallana, 91
jacksoni, 91
minor, 90, 91
obtusa, 91
rogersi, 91
roemeriana conferta, 92
Archaeosigillaria chemungensis, 91
corrugata, 91
gaspiana, 91
primaeva, 91
simplicitas, (85), 91
vanuxemi, 91
Astrochlaena noveboracensis, 91
Atrypa reticularis, 59, 69
Aviculopecten, 45
Beyrichia, 91
Bothriolepis, 62
minor, 90-92
nitida, 91, 92
Brachiopoda, 45
Callixylon, 91
Camarotoechia contracta, 69
Caulopteris lockwoodi, 91
Cephalaspis, 91
Cladodus coniger, 92
Cladoxylon mirabile, 91
Clams, 42; *see also* Lamellibranchiata
Cordaites clarkii, 91
Crinoids, 46
Ctenacanthus chemungensis, 90, 92
nodocostatus, 92
Cyclostigma affine, 91
Cypricardia, 42, 43; *see also* Ar-
chanodon
angulata [*Goniophora chemungen-*
sis?], 43
catskillensis, 43; *see* Archanodon

**Spellings corrected, when not
same as text.

- Cypricardites catskillensis, 26, 54; *see also* Archanodon
- Cypricardites chemungensis, 45; *see also* Goniophora
- Delthyris**, 28
- Dictyocordaites lacoii, 91
- Dinichthys curtus, 91, 92
pustulosus, 91
tuberculatus, 90-92
- Dipleura dekayi, 43
- Dipterus alleganiensis, 92
contraversus, 92
flabelliformis, 92
minutus, 92
nelsoni, 92
quadratus, 92
sherwoodi, 92
- Eospermatopteris**, 91
erianus, 91
textilis, 91
- Estheria membranacea, 91
- Eurypterus approximatus, 92
- Fish**, 23, 30, 42, 45, 46, 53, 55, 58, 80, 90
- Fucoids, 14, 20, 23, 46
- Ganorhynchus beecheri**, 92
oblongus, 92
- Glyptopomus sayrii, 91
- Goniophora chemungensis, (43?), 45
- Gyracanthus sherwoodi, 92
- Helodus gibberulus**, 92
- Holonema rugosum, 90-92
- Holoptychius, 46, 47, 50, 54, 55, 91, 92
americanus, 90-92
flabellatus, 92
giganteus, 92
halli, 91
latus, 92
nobilissimus, 92
pustulosus, 92
radiatus, 92
serrulatus, 92
- Homacanthus acinaciformis, 92
- Hormoxylon erianum, 91
- Lamellibranchiata**, (42), 45
- Leiorhynchus globuliforme, 59, 69
- Lepidostrobos gallowayi, 92
- Microdon bellistriatus**, 43
- Onchus rectus**, 91
- Orthis, 43
- Paracyclas lirata**, 59, 61
- Paramphibius didactylus, 91
tridactylus, 91
- Planolites clarkii, 91
- Plants, 10-12, 20, 22, 25, 30, 42, 45, 48, 62, 70, 80, 90
- Productella speciosa, 69
- Protolipidodendron, 91
- Protosalvinia, 91
huronensis, 91
- Psilophyton, 92
princeps, 91
robustum, 91
- Rhachiopteris**, 91
cyclopteroides, 91
tenuistriata, 91
- Rhachiopteroides pinnatus, 91
punctatus, 85, 91
- Rhadinichthys, 92
- Rhizodus, 92
- Rhodea, 92
pinnata, 91
- Sagenodus**, 92
angustus, 92
fleischeri, 91, 92
- Sauripterus taylori, 90-92
- Shells, 20, 80
- Sigillaria gilboensis, 91
simplicitas, 85; *see also* Archaeo-sigillaria
- Spirifer disjunctus, 65, 69
mesastrialis, 45, 62, 65, 69
- Stethacanthus depressus, 92
tumidus, 91, 92
- Stumps, 43, 50, 56; *see* Trees
- Stylonurus excelsior, 91
lacoanus, 91
- Taenioocrada chondriformis**, 91
lesquereuxi, 91
lineata, 91
- Tentaculites, 43
- Testacea, 10, 12, 30; *see also* Shells
- Thinopus antiquus, 92
- Trees, 43, 50, 51, 71; *see also* Stumps
- Trochophyllum breviinternodium, 92
- Tropidoleptus carinatus, 69

C. The Localities:

- Adirondacks**, 21
 Albany, 4, 8, 9, 38, 70, 86, 97
 Albany county, 4, 8, 12, 31, 43, 58, 65, 72, 77, 95
 Allegany county, 36, 37, 50
 Altoona, 44
 Andes, 4, 8, 46
 Appalachian region, 62, 107
 Apulia, 59
 Arkansas, 28
 Austin's Glen, 28
- Beach's Mountain House**, 21; *see also* Mountain House
 Berne, 4, 12
 quadrangle, 77
 Bingham, 78
 Binghamton, 4, 8, 69
 Black Dome, 8, 38, 39, 70
 Blackhead (a twin peak of Black Dome), 38
 Blossburg, 21, 23, 24, 55, 80
 Bradford county, 8, 44, 90, 98
 British Isles, 24
 Broome county, 4, 8, 25, 40, 64, 93
- Canada**, 107
 Canajoharie & Catskill railroad, 28
 Canandaigua, 99
 Capital District, 5
 Carbondale, 7, 8, 11, 95, 96
 Catskill, 13, 31; *see also* Kaaterskill
 Catskill ("creek"), 4, 13, 28, 31
 Catskill area or region, 6, 11, 33, 38, 40, 50, (51), (74), 75, 82, 88, 95, 96
 Catskill Mountain House, 17, 38, 95; *see also* Mountain House
 Catskill Mountain railroad, 4, 16, 28
 Catskill mountains (Catskills), and synonyms, 5-8, 12, 13, 20, 21, 24, 26-38, 40, 41, 44, 47-50, 52-63, (65), 66-68, 70-74, 76-89, 94-96, 98-101, 107
 Catskill outskirts, 48, 96
 Catskill plateau, 34, 40, 58, 85, 86, 100, 107
 Catskill quadrangle, 5, 21
 Catskill township, 16, 79
 Catskill (village), 4-6, 8, 9, 11, 13, 17, 20, 21, 38, 54, 58, 59, 77, 97
 Catskills, *see* Catskill mountains
- Cattaraugus county, 36, 37
 Cattskill, Catskills; *see* Catskill; Catskill mountains
 Cayuga county, 94
 Cayuga lake, 93
 Central New York, 25, 48, 49, 65, 70, 87
 Champlain, *see* Lake Champlain
 Chemung, 99
 Chemung Narrows, 43
 Chenango canal, 64
 Chenango county, 4, 8, 25, 56, 62, 69, 84, 93
 Chenango valley, 8, 69, 72
 Church in valley, 13, 19; *see also* Kiskatom Dutch Church
 Cleveland, 99
 Clove, *see* Kaaterskill Clove
 Coal fields or regions, 7, 23
 Cornwallville, 4, 8, 27, 67
 Cotton creek, 78
- Delaware county**, 4, 7, 8, 11, 26, 31, 39, 43, 46, 56, 68, 83, 84, 95, 96, 98
 Delaware river, 4, 8, 30, 40, 66, 72, 86, 97
 Delaware valley, 68
 Delhi, 4, 8, 46, 70
 Deposit, 4, 8
 Durham, 4, 8, 20, 27, 65, 71
 Durham quadrangle, 77
- East Durham**, 4, 27
 Eastern New York, (4), (8), 44, 49, 65, 70, 77, 87, 88; *see* First District
 Ellicottville, 36
 England, (22), 24
 Erie, *see* Lake Erie
 Erie county, 99
 Esopus valley, 4, 8, 10, 66
 Essex, 94
 Europe, 23, 29, 59, 80
- First District**, 7, 8, 12, 13, (26), 28, 30, 31, 41, 47; *see also* Eastern New York
 Florence, 94
 Florence village, 94
 Fourth District, (24), 31, 47; *see also* Western New York
 Franklin, 4, 8, 45, 46, (47), 55, 56, 59, 64, 69, 73, 80, 83, 84, 99
 Fulton, 94

- Genesee**, 78
 Genesee river, 93, 99
 Gilboa, 4, 8, 38, 42, 43, 50, 51, 53, 56, 71, 82
 Glasco, 4, 8, 52
 Great Britain, 80
 Greene county, 4, 5, 7, 8, 11, 16, 20, 27, 28, 31, 43, 62, 66, 67, 70-72, 74, 76, 77, 83, 95
Haines Falls, 4, 8, 16, 74, 76, 77
 Helderberg range, 8, 38
 Herkimer county, 93
 Highlands, 8, 86
 High Peak, 8, 10, 16, 36, 39, 76
 Hudson river, 4, 8, 33, 61, 67, 70, 86, 87, 97
 Hudson valley, 10, (58), 61, 67, 68, 71, 72, 77, 96, 100
 Hunter mountain, 10, 39
Ithaca, 69, 99
Jefferson, 4, 8, 43
 Jones Beach, 21
Kaaterskill ("creek"), (4), 10, 13, 16, 20, 21, 31, 74, 75, 77
 Kaaterskill Clove, 8, 16, 38, 52, 55, 74, 75
 Kaaterskill Falls, 16, 74
 Kaaterskill High Peak, *see* High Peak
 Kaaterskill quadrangle, 5, (8), 10, 16, (21)
 Kaaterskill Round Top, *see* Round Top
 Kiskatamine creek, (16), 19, 21
 Kiskatom, 21
 Kiskatom Dutch church, (13), (19), 21, 96
Lake Champlain, 94
 Lake Erie, 93, 99
 Leeds, 4, 8, 28
 Lehigh (river), 72
 Long Island, 21
 Lyon brook, 8, 61, 62
Madison, 28
 Manorkill, 4, 42, 43
 Manorkill falls, 42, 53
 Medina, 94
 Mississippi valley, 36, 58
 Mohawk valley, 34, 84, 87
 Mohawk village, 93
 Montrose, 8, 25, 59
 Moosic mountains, 8, 11
 Mount Upton, 8, 42, 54
 Mountain House, 8, 10, 13, 16, 17, 20, 21, 31, 38, 39, 48, 53, 54, 58, 65, 66, 95, 100
 Mountain Road, (16), (17), (20), 21, 32, (78)
New Jersey, 72
 New York, 4-6, 8, 21-26, 30, 31, 33, 34, 36-40, 44-52, 55, 61, 67-70, 73, 74, 76, 79-87, 89, 90, 93, 94, 96, 99, 100, 107; *see also* Eastern New York; Central New York; Western New York
 North America, 23, (24)
 North mountain, 16, 39
 Northern New York (Second District), 93
 Norwich, 4, 8, 56, 64
Ohio, 88
 Ohio line, 78
 Ohio valley, 87
 Olean, 36, 99
 Olean region, 68, (99)
 Oneida county, 94
 Oneonta, 4, 8, 21, 25, 40, 45, 46, 54, 58, 59, 62-64, 79, 94, 99
 Oneonta quadrangle, 64
 Onondaga county, 8, 94
 Onteora Park, 8, 76
 Oswego county, 94
 Oswego river, 94
 Otsego county, 4, 8, 25, 56, 62, 69, 84, 90, 93, 94
 Overlook (mountain), 8, 10, 39
Palenville, 4, 8, 10, 16, 52, 53, 55
 Pennsylvania, 5-7, 11, 12, 21-25, 31, 33, 34, 36, 38, 40, 44, 47, 48, 50, 51, 55, 59, 65, 66, 70, 72, 78, 81-83, 85, 86, 89, 90, 94, 96, 98-100
 Pennsylvania line, 8, (23), 82
 Phoenicia quadrangle, 10
 Pine Orchard, 13, 20
 Pocono mountains, 37
 Pocono plateau, 37, 78, 101
 Port Crane, 4, 8, 64, 69

- Port Deposit, "Pa." [? Deposit, N. Y.], 83
- Port Jervis, 4, 8, 66, 68
- Post's creek, 27
- Post's mills, 20, 27, 29, 32, 98
- Potter county, 78
- Potter Hollow, 4, 8, 71
- Poughkeepsie, 4, 8, 86
- Prattsville, 4, 8, 42, 43
- Rensselaerville**, 4, 12
- Rip Van Winkle Clove (Sleepy Hollow of map), 16, 17, 21
- Rip Van Winkle hotel ("shanty in ravine"), 13, 14, 20, 21
- Rip Van Winkle trail, 21, (77)
- Rochester, *see* University of Rochester
- Round Top (Roundtop), 8, 10, 16, 34-36, 52, 76
- Schenevus**, 4, 8, 52
- Schoharie, 4, 8, 11, 46, 79, 99
- Schoharie county, 4, 7, 8, 11, 31, 43, 82, 95
- Schoharie creek or kill, 4, 8, 10, 42, 53
- Schoharie valley, 12, 30, 58, 68, 71, 72, 77, (99)
- Second District, *see* Northern New York
- Shady Glen, 27
- Shanty in ravine (Rip Van Winkle hotel), 13, 14, 20, 21
- Silver creek, at Oneonta, 64
- Sleepy Hollow (Rip Van Winkle Clove), 16, 17, 21
- Slide mountain, 4, 8, 10, 39, 58, 76, 78, 79, 87, 95, 96, 98
- Southern New York, 96
- South mountain, 13, 16, 20, 21, 31, 39, 95, 96
- Steele's creek, 93
- Steuben county, 50
- Stevens mountain, 42
- Stone bridge (Webber's), 13, 20, 21
- Stoppel, 10, 16, 39
- Sullivan county, 4, 7, 8, 11, 31, 62, 95
- Susquehanna county, 8, 25, 26, 85, 94
- Susquehanna river, 4, 8, 29, 40, 45, 54, 59, 70, 72, 94
- Table rock** (at Mountain House), 13, 31
- Tannersville, 4, 8, 21, 77
- Third District, 8, 12, 25, (26), 29-31, 47, 59, (94)
- Third ledge, 32, 39, 53, (95)
- Tioga, 49
- Tioga county, N. Y., 8, 25, 93
- Tioga river, 23, 50
- Tioga valley, 50
- Tollgate at foot of mountain, 13, 16, 19
- Ulster county**, 4, 7, 8, 11, 16, 26, 31, 58, 66, 67, 70, 83, 95, 100
- Ulster & Delaware railroad, 4, 62
- Unadilla, 4, 8, 42, 99
- Unadilla valley, 77, (99)
- University of Rochester museum, 79
- Warren**, 92
- Watkins Glen, 69
- Webber bridge, (13), (20), 21
- Wellsville, 36
- Westerlo, 4, 12
- Western New York, 23, 24, 31, 48, 49, 62, 78
- Wittenberg, 8, 10, 39, 78
- Woodstock, 4, 8, 10, 53
- D. Surnames, Societies, Surveys.**
- Ashburner**, 33-35, 39, 52, 53, 58, 86; 103, 104, 107
- Barrell**, 70; 106
- Beecher**, 61; 103
- Berkey**, 58, 66; 106
- British Geological Society**, 51
- Callaway**, 24; 103
- Caster**, 75, 88, 89, 96; 107
- Chadwick**, 32, (41), (43), (47), 58, 59, (64), 70-75, 77-79, (83), 86, 88-90, 96, (98); 106, 107
- Chance**, 34, 58, 86; 103
- Clarke**, 28, 36, 58, 59, 65, 67-70, 90; 105-107
- Conrad**, 7, 22-25, 29, 40, 59, 72; 101, 102
- Cooper**, 43, 59, 71, 73, 77, 79; 106, 107
- Dana**, 28, 34, 44, 58, 59, 67, 69, 87; 102, 103, 105
- Darton**, 39, 47, 58, 59, 64-67, 69, 70, 85, 87, 96, 100; 104
- Dawson**; 102

- Eaton**, 24
Emmons, 11, 24, 37, 38, 41-44, 48, 58, 59, 64, 90, 93, 100, 101; 102
Fuller, 58, 68; 105
Geological Society of America, 58, (70), (71), (77), 79
Glenn, 58, 68; 105
Goldring, 59, 70; 106
Grabau, 52, 58, 62, 66, 70; 106
Hall, C. E., 61
Hall, James, 21-26, 28, 35-41, 43-66, 68, 69, 80-84, 86, 93, 100; 102-104
Hall, J. W., 61, 81
Hartnagel, 37, 58, 59; 106
Hopkins, 28
Jewett, 45, 48, 55, 59, 80, 81, 83, 84; 102
Kay, 58, 75; 107
Kindle, 69, 80; 105, 106
Lesley, 33, 34, 39, 44, 51, 53, 58, 59, 61, 69, 78, 86; 103
Lincklaen, 22, 28, 36, 44, 58; 102
Logan, 51
Macfarlane; 104
Map of 1842 (1843), 21, 31, (47), 49, 52, 53, 58, 59, 82, 97
Map of 1844, 21, 31, 53, 58, 59, (97)
Map of 1875, 35
Map of 1894, 58, 59, 67, 68, 97
Map of 1901, 52, 58, 59, 68, 97
Marcou, 23
Mather, 7, 8, 11, 12, 16, 17, 20-27, 29-34, 37-42, 44, 47-49, 53, 58, 59, 63, 66, 67, 75, 76, 78, 85, 86, 89, 90, 93-96, 98, 100, 101; 101, 102
McGee, 58, 59, 67-69; 105
Merrill, 11, 22, 23, 36, 39, 44, (52), 58, 59, 68, 69, 95; 105
Miller, S. A., 28, 34, 41, 87, 90; 103, 104
Miller, W. J., 70; 106
Monahan; 106
Murchison, 22
Nason, 58, 67; 105
Newberry, 51, 58, 59, 81, 82, (83), 87; 103, 104
New York Geological Survey, or **Museum**, (5), (21), (22), 24, 25, (29), (31), 33, 47, (49), (50), 51, (52), (53), (58-61), 76, 83, (93), 101; 102
Owen, 28
Pennsylvania Geological Survey, 22, 29, 30, 33, 34, 36, 44, 47, 50, 51, (52), 66, 95, 98
Phillips, 37
Post, 27
Prosser, 41, 43, 47, 51, 58, 59, 62, 64-70, 72, 80, 90; 104, 105
Ramsay, 51
Randall; 103
Regents, 83
Rogers (Rodgers), 7, 35
Ruedemann, 70; 106
Schuchert, 58, 59, 67; 105
Sections:
Mather's, 13-20, 31, 58
Mather's Post's mills, 27
Schenevus to Glasco, 52
Sherwood's, 52-53, 58
Sherwood, A., 16, 34, 35, 39, 51-53, 55, 58, (63), 64, 68, 76, 82-84, 90; 103
Sherwood, C., 34, 35, 39, 51, 82
Shimer, 77; 107
Simpson, 81
Smock; 104
Stein, 17
Stevenson, 23, 63, 85, 90, 95; 104
Taylor, 23
Van Loan, 32
Vanuxem, 8, 12, 13, 25-30, 32, 40-42, 44, 47, 49, 51, 59, 63, 64, 66, 71, 72, 76, 85, 90, 93-95, 98, 101; 101, 102
Way, 45, 48, 64, 80, 84
White, 26, 51, 59, 63, 85; 103
Willard, 51, 72-75, 79, 86, 89, 90; 106, 107
Williams, H. S., 25, 40, 58, 59, 62, 67-70, 80, 87, 89, 90; 103-106
Williams, J. S., 77; 107
Winchell, 48, 49, 81; 102

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