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TABLE OF CONTENTS

VOLUME VI.

ILLUSTRATIONS

N. R. Graves, Photo.

THE ROCHESTER CANYON

View looking south, upstream, toward Driving Park Avenue bridge

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
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THE ROCHESTER CANYON
AND
THE GENESEE RIVER BASE-LEVELS

BY HERMAN L. FAIRCHILD

(*Presented before the Academy May 13, 1918*)

CONTENTS

ILLUSTRATIONS

Introduction

In the course of the Genesee River lie three ravines: the Portage Gorge, the Mount Morris "High Banks," and the Rochester Canyon. These narrow, steep-walled sections of the river valley are the youngest portions of the valley, being the sections where the river has been recently forced, by glacial interference, into new paths. In these ravine sections the river has been flowing only some tens of thousands of years, or since the latest ice sheet disappeared; while the broad, open stretches of the valley represent millions of years previous to the Glacial Period.

The canyon of the Genesee at Rochester is superior in both scenic beauty and scientific interest. Somewhat smaller than the gorge at Niagara, and with much less volume of the river flow, it excels in the beauty of its wooded banks and in the variety of the rock strata. The section of strata on the Genesee is classic in American Geology. The general history and the stages in the canyon erosion are identical for the two sister streams, Niagara and Genesee; but the latter gains in scientific interest by the three falls to offset the grandeur of the single Niagara. The height of Niagara is 160 feet; the three Rochester falls total 228 feet. Lying through and adjacent to the city, with miles of smooth navigable river opening to Lake Ontario, between high walls covered with primeval forest, it affords unusual opportunity for recreative use to multitudes of people.

Of course the canyon has been excavated by the river, aided by the destructive action of the atmosphere on the walls. The river did not discover the ravine, the river made it. Rivers are the valley-makers.

A person who is not informed on the local geology would probably say that the Genesee River has simply carved its channel in its fall toward Lake Ontario. But this erosion or intrenching of the stream has not been a steady or continuous process, or without interference. After the student learns that the gravel ridge which carries the "Ridge Road" is the deserted beach of a long-lived glacial lake (Lake Iroquois), he might suppose that the river at first excavated the ravine down to the level of the Lake Iroquois, and that after Iroquois disappeared the lower part of the ravine, beneath the level of the Ridge Road, was excavated. This explanation would be incomplete, because a glacial lake lay over Irondequoit Bay and the northern part of the city previous to Lake Iroquois. And Lake Ontario was not the immediate successor of Iroquois. Between the time of Iroquois and Ontario, some thousands of years, an arm of the ocean occupied the St. Lawrence Valley and the Ontario Basin. During that time the Genesee River poured into Gilbert Gulf, an arm of the Champlain sea (figure 4). The site of Charlotte was then only 91 feet above the sea (see the diagram, figure 8).

Furthermore, the succession of water levels is not the whole complication, for the reason that during the life of the several water bodies this part of the continent was rising, with tilting uplift, thereby introducing peculiar complexity in the water levels.

The reader who wishes to know a real romance of science, the drama of the later Genesee history, may read the following pages. It will not be easy reading, for it requires the scientific or constructive imagination in order to picture the changing conditions and to carry in mind the complex relations of the geologic factors.

Pre-Glacial Genesee River; Irondequoit Valley

For many millions of years before the Glacial Period the predecessor of the Genesee River, which we may call the ancient Genesee, flowed through the valley of Irondequoit (plate 2). That broad and deep valley, now much filled with glacial and lake deposits, was excavated from the solid rock strata by the river erosion, aided by storm-wash, frost and chemical decay. The ancient river passed north and joined a great river or trunk-stream in the bottom of the Ontario valley. At that time there was no Lake Ontario, and probably on lakes in eastern America. The Ontario Valley, like the Irondequoit, was carved out of rock strata by the combined work of river and atmospheric agencies. Since the bottom of Lake Ontario, as well as the rock bottom of the Irondequoit Valley, is far below sea-level it is evident that this part of the continent was very much higher above the sea than it is today. Judging by the drowned valleys about the ocean shores the continent must have been, in one of its ups-and-downs, 1000 or 2000 feet higher during some phase of Pre-Glacial time.

Before the ice age the ancient Genesee flowed northward past Avon, as today, but then turned eastward, along the outcrop of the weak Salina shales, somewhere in the district of Rush or the course of the lower Honeoye Creek. In some unknown course the river swung northward, into the valley we call Irondequoit. This indirect course had been produced by the adjustment of the old drainage to the structure, or varying resistance, of the underlying rock strata. It should be stated that the Genesee River was not created as a unit, the entire length at once, but is the product of union by stream capture of several streams, during a vast length of time.

The latest ice sheet, the Labradorian (Quebecan) glacier, swept a mass of rock-rubbish, "glacial drift," into the east-and-west section of the old valley, somewhere between Rush and Fishers. When the ice sheet melted away and the glacial lakes which faced the ice front were drained down, and the river flow was resumed, the latter found the old channel obstructed by the drift blockade. The river, naturally, took the lowest path it could find, winding among the drift hills north of Avon, and crossing the Pinnacle moraine, established its present course (plate 2).

Post-Glacial Land Uplift

Figures 5–7.

The rise and fall of great areas of the earth's surface, very slowly as judged by human experience, is the fundamental and simple fact of geology. The rocks beneath the City of Rochester, a sequence of limestones, shales and sandstone, were laid as sediments in shallow oceanic waters many millions of years ago. Since the Rochester strata were deposited this region has been involved in great oscillations of level. These uplifts and downthrows (diastrophic movements) have continued through millions of years down to the present time; and the very recent rise of the land has caused remarkable changes of level in the standing waters, which were the baselevels of drainage; thus limiting the flow and work of the Genesee River at Rochester and Charlotte.

One proof of recent change in land level, which the reader will readily appreciate, is recorded in the Iroquois beaches. The Ridge Road lies on the gravel embankments or bars built by the waves of the great glacial Lake Iroquois; or, in a few places, on erosion shelves cut by the waves in the land surface. The south shore of the lake has been mapped throughout its whole extent, from

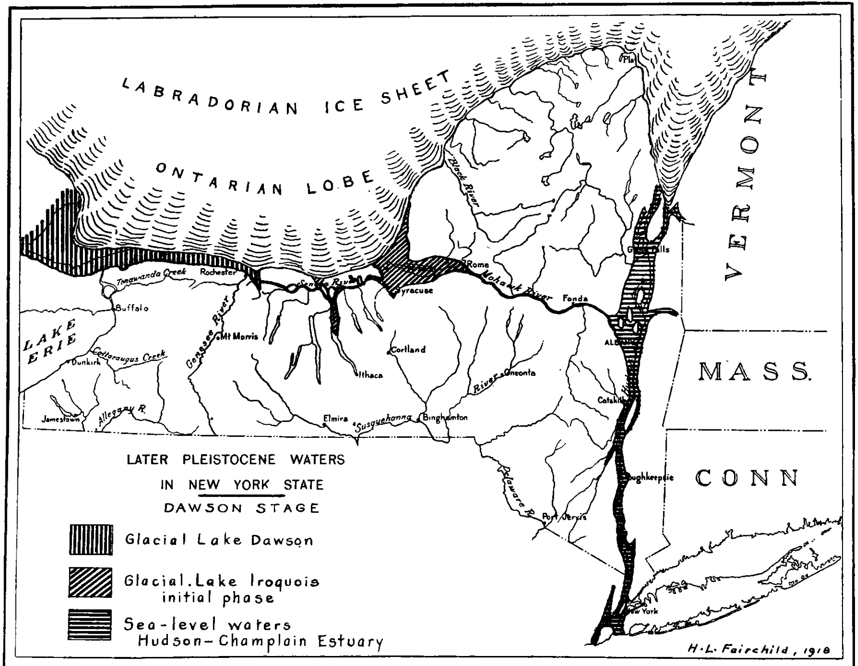


FIGURE 1. *Dawson Stage of the Glacial Waters*

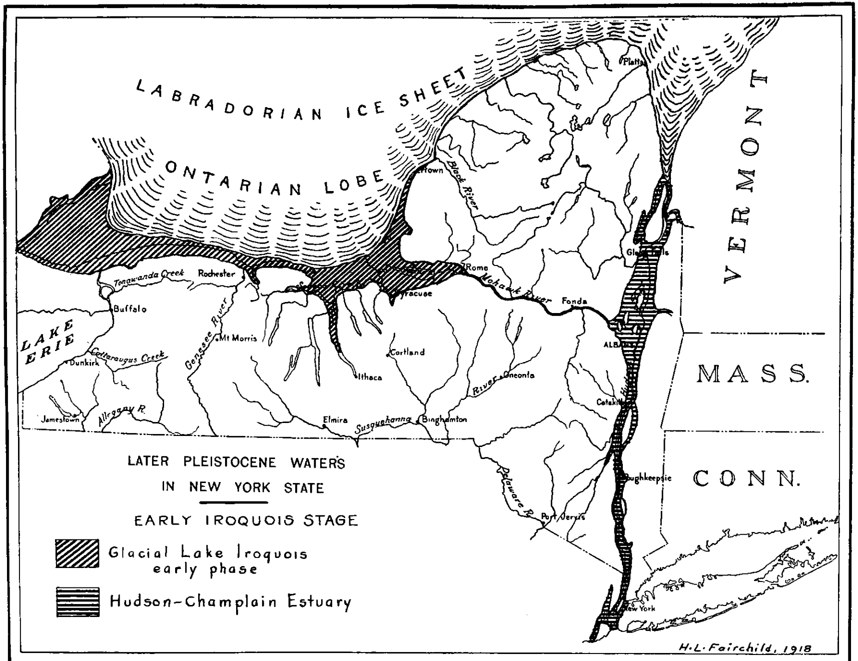


FIGURE 2. *Early Iroquois Stage*

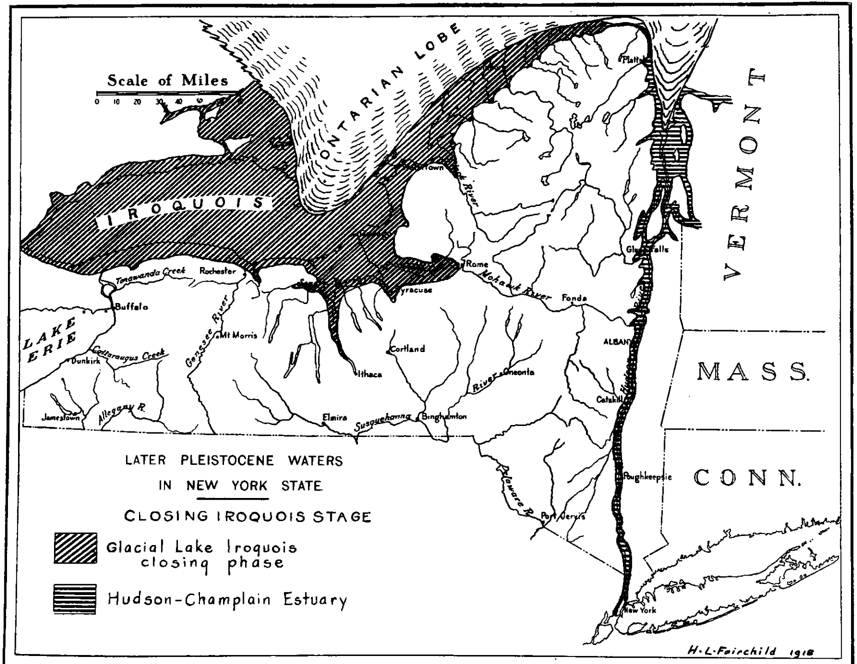


FIGURE 3. *Closing Iroquois Stage*

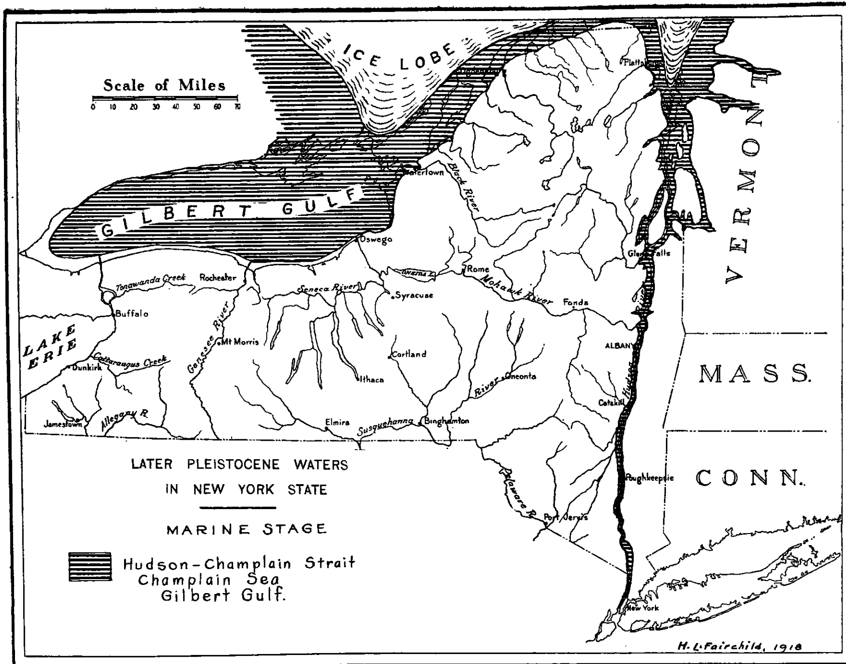


FIGURE 4. *Gilbert Gulf, Sea-Level Waters*

Hamilton, Ontario, to its final outlet on the north border of the State. When the lake arrived at the time of its extinction its surface and its shoreline must have been level. This is the first important fact in the study. Moreover, if there has been no change in the height or attitude of the land in Post-Iroquois time then the ancient shoreline must still be level. The same would be true if the area of New York and adjacent territory has been raised or lowered without any tilting. Now, what is the fact? At Hamil-

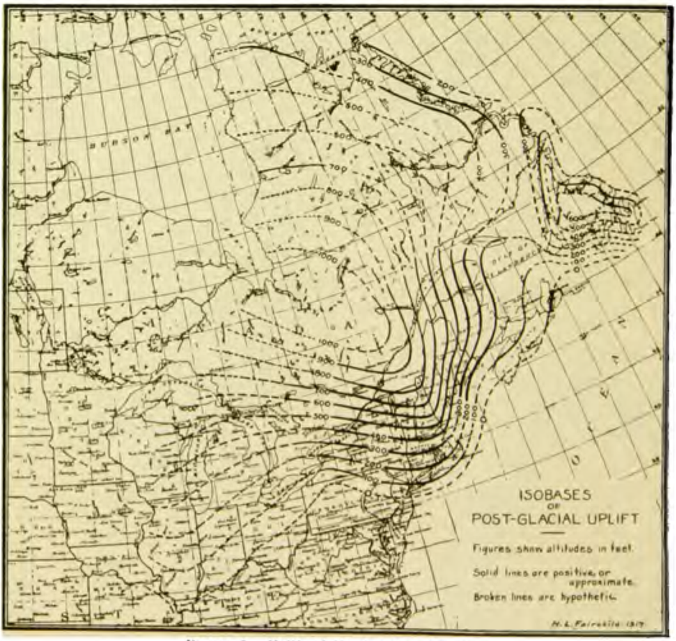


FIGURE 5. *Uplift of Northeastern America*

ton, Ont., the Iroquois beach is today 362 feet above ocean. At Rochester it is 435 feet; at Watertown 671 feet; and at Covey outlet 1030 feet (see tabulation, figure 7). There has been a

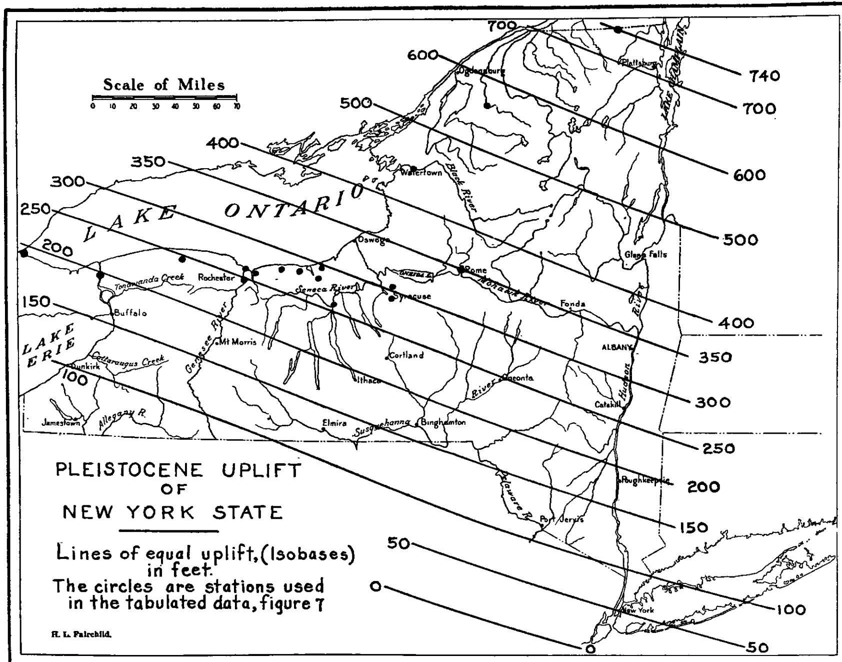


Figure 6. *Tilting Uplift of New York*

tilting, or differential uplift, between Hamilton and Covey of 668 feet. And we have sufficient evidence that the tilting has been produced by rise at the northeast end of the basin, and not by any sinking at the west end.

We have clear proof, therefore, that this part of the continent has risen, accompanied with northward up-tilting, in recent time. Perhaps the uplift has not entirely ceased; at least for Canada. This fact of recent tilting uplift of New York State is most important in the study of the local water levels, and should be clearly understood by the reader. The maps and tabulation (figures 5–7), are requisite.

Lake Dawson History; Fairport Channel

Plates 2, 3.

A series of glacial lakes, at successively lower levels, had existed in the Genesee Valley as the front of the waning glacier receded northward. These lakes had outlets at different times to the Susquehanna; to the Mississippi by different routes; and to the Mohawk-Hudson, giving the most complex and dramatic drainage history of any valley, probably, in all the world. The story of the Genesee glacial waters has been partially told in former writings (see numbers 14, 23 of the attached list of writings) and does not belong here, as the present paper begins with the Lake Dawson episode.

When the ice sheet had melted off from the site of Rochester and from the larger part of the Irondequoit Valley, but while the ice front lay north of the city and across Penfield town, east of the Irondequoit Valley, a glacial lake occupied as much of the west end of the Ontario basin as the ice sheet had deserted. This waterbody is called Lake Dawson (23, page 58). It had its outflow in Fairport, through the capacious channel leading east, past Palmyra, Newark, Lyons and Clyde; and poured its flood into the Lake Montezuma in the Cayuga depression, and eventually to the primitive Lake Iroquois wkhich then lay over the district from Rome to Syracuse (plates 2, 3).

The floor of the Fairport channel, on the divide, is today 460 feet (see plate 2). If we allow about 15 feet for the depth of water in the great river, and 5 feet for the difference of land uplift between Fairport and Rochester, we have 480 feet for the altitude of the Dawson shore about the city. This shore is found to lie at the junction of East Main Street and Culver Road, forming the east-facing slope at the University Athletic Grounds; and it curves around through the north part of the older city on the 480 contour of the topographic map, or about 45 feet higher than the Iroquois plane. The Dawson features, as well as the Iroquois, are shown in plates 2, 3. The shore features are weak and inconspicuous, because the lake had a relatively short life, and also for the reason that the surface level was probably falling as the Fairport river deepened its channel, first in drift and then in the Salina shales.

During Dawson time Lake Erie and Niagara River had come into existence (23), and the waters of the Great Lakes area, as much as the ice had uncovered, along with the copious flood from the melting of a thousand miles of ice front, passed eastward through Lake Dawson toward the sea, in the Hudson Valley. The valley at Fairport and on to Lyons carried an immense river, a predecessor of the St. Lawrence.

The mouth of the Genesee River during Dawson time was probably at about the location or level of Lorimer and Scrantom Streets. The part of the Genesee ravine south of this locality, and above the upper falls, was in progress of cutting. Beneath the level of what is now 480 feet no river channel then existed; the horizontal strata being uncut and continuous.

The maps, figures 5, 6, and the tabulated data, figure 7, show that the total amount of land uplift at Rochester has been 250 feet, since the ice melted off. Substracting this from 480 the present uplifted altitude of the Dawson shore gives us 230 feet as the actual height above sea of the Lake Dawson water surface.

The extinction of Lake Dawson occurred when the ice sheet, lying across Penfield, receded a few miles and permitted Lake Iroquois to penetrate westward and around into the Irondequoit Valley. Then the Dawson waters fell to and blended into Lake Iroquois. The surface of Iroquois was then about 110 feet above sea. The fall in water level, and the further drop of the Genesee River, was from 230 feet down to 110 or 120 feet. This relation of the water levels is shown in figures 8, 9.

Lake Iroquois History

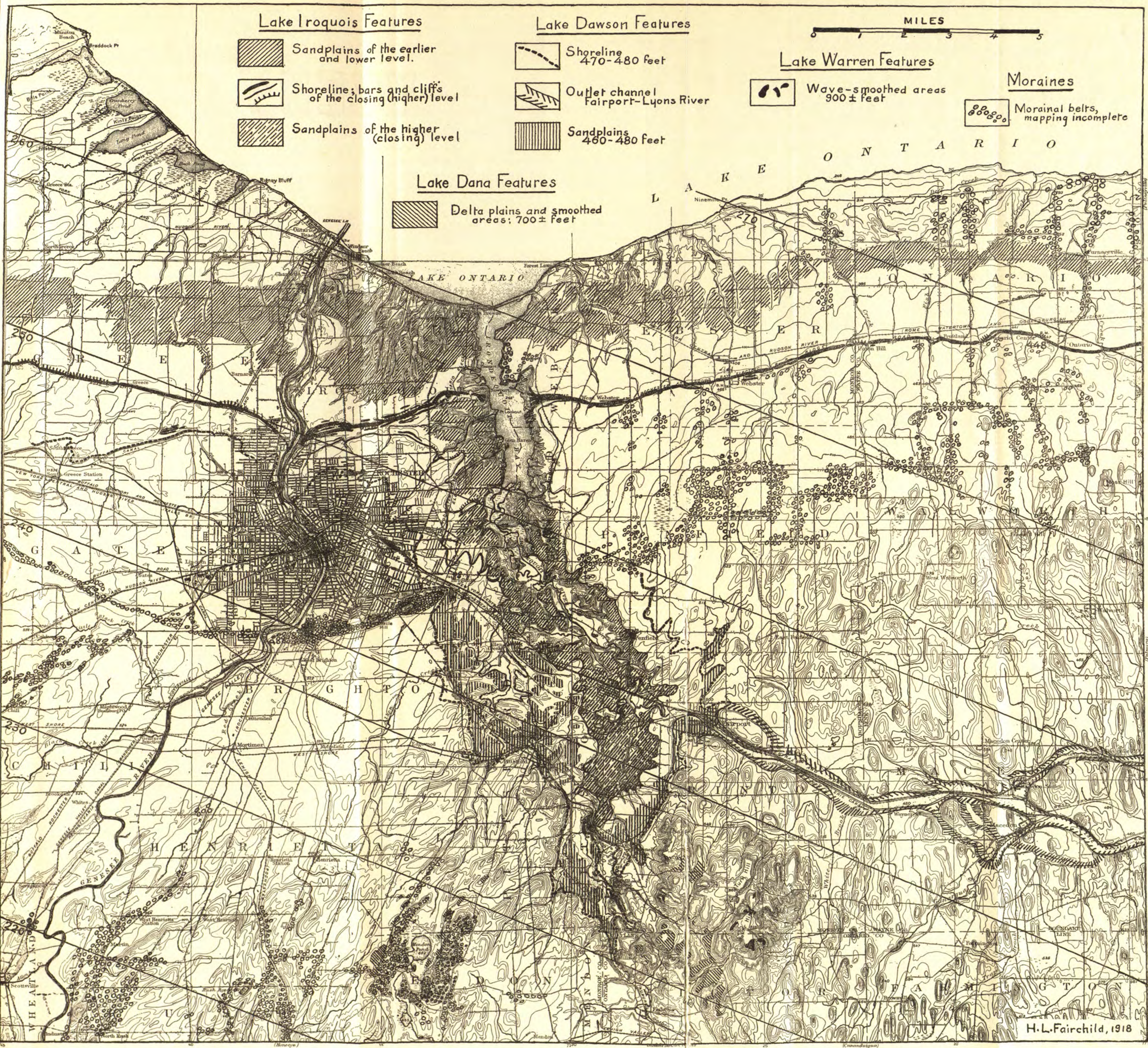
Plates 2, 3; Figures 2, 3.

In contrast with Lake Dawson the Lake Iroquois was long-lived, and produced remarkable shore phenomena; long stretches of heavy gravel ridges and conspicuous erosion cliffs. It was the latest glacial lake in eastern America, at least of any note; was one of the largest in area and longest in life, and affords us the fullest knowledge. During most of the life of that ice-impounded lake the outlet was at Rome, N. Y., with outflow down the Mohawk Valley to the ocean in the Hudson Valley. The great sandplain extending from Schenectady to Albany, and southward, is the delta built at sea level by the river, called Iromohawk. This relation and outflow persisted as long as the latest ice sheet lay over the St. Lawrence Valley. As the glacier diminished, and its south front receded northward, the waters of Iroquois extended northeastward, penetrating between the waning ice margin and the northwest slope of the Adirondacks, and eventually found a second outlet at Covey Pass, on the international boundary at the north edge of the State (figure 3).

When the ice front backed away a little distance, about three miles from the State line; on the steep north face of Covey Hill, the waters of Lake Iroquois were drained down to ocean level. Then the sea-level waters, Gilbert Gulf (figure 4), took possession of the Ontario Basin. But this was some thousands of years before Lake Ontario came into existence.

As a lake level is determined and controlled by the height of its outlet, the rise at Rome of 180 feet during Iroquois time (figure 7), produced corresponding rise of the entire lake surface. It is an important fact that all the Iroquois shores south of the Rome isobase (figure 6) were shaped by rising waters. The large gravel ridges of wave construction, with high and steep lakeward faces, and with no subordinate flutings or deserted bars below 20 or 25 feet, indicate construction in rising waters. The huge ridge at Hamilton, Ont., is the best example (10).

The Iroquois water plane at Rome is today 460 feet, being determined by several gravel bars southwest of the village. The total uplift there is 350 feet, which leaves 110 feet as the intial height of that plane. There are reasons for thinking that the earliest outlet



PLEISTOCENE GEOLOGY OF THE ROCHESTER DISTRICT

This map includes the Rochester and Macedon quadrangles. Plate 3 joins it on the east. The oval hills are drumlins. The lines across the map indicate, in feet, the total amount of Postglacial land uplift.

PLEISTOCENE GEOLOGY OF THE PALMYRA AND CLYDE QUADRANGLES

This map joins plate 2, and shows the eastward continuation of the Fairport-Lyons River (the outlet of Lake Dawson) and the beaches of Lake Iroquois. The dotted areas are delta plains built in Lake Montezuma. Except on the lines of equal land uplift (isobases) the numerals show the present altitude above ocean. This district is the heart of the drumlin area of central New York.

of the primitive lake (figure 2) had a lower plane than the floor of the present channel at Rome (26 page 38). If that is true then the primitive lake was lower than 110 feet. We see no way at present of measuring the amount of rise at Rome previous to the time when the Iroquois waters reached the Irondequoit Valley and Rochester. The height might have been somewhat under or over the 110 feet. For the present purpose we assume the height as 110 feet. Whatever error there may be in this figure is of no large consequence in the succeeding history, as it has no effect on any later data.

Changes of Land Level; Tabulation of Data

Figure 7.

In a former publication (29) the relation of the several uplifted water planes in New York was discussed, and a tabulation was used that included some Canadian stations. In the table here given, figure 7, more New York stations are used, and some of the numerals are slightly changed. A brief description of the manner in which the figures of the table are derived will be helpful to the reader.

At Covey outlet, the second and latest discharge of Lake Iroquois, the upraised marine plane is 740 feet. The shore features produced by the sea-level waters have been traced from the vicinity of New York City up the Hudson and Champlain valleys to Covey Hill, and about that salient. Splendid series of heavy gravel bars at about 735 feet lie southeast of Covey pass, on the Champlain side of the highland; and similar beaches at accordant altitude on the St. Lawrence side of the salient. The marine shore has been traced in the St. Lawrence Valley, southwest from Covey Hill, until it passes beneath the waters of Lake Ontario east of Oswego (20).

The Iroquois level at Covey Hill is 1030 feet. The vertical interval of 290 feet between the Iroquois and the marine planes determines the height of Lake Iroquois above the sea at the time of its extinction. It is believed, moreover, that so little tilting of the land occurred during the short episode of the down-draining of Iroquois that we may regard the 290 feet as correctly represent-

		Hamilton, Ont.	Lewiston.	East Gaines.	Rochester.	Charlotte.	West Webster.	Ontario.	Sodus.	Rose.	Wolcott.	Montezuma.	Syracuse.	Woodard.	Rome.	Watertown.	Russell.	Covey.
A	Total land uplift, by isobases. (See maps, figures 5, 6.)	185	195	245	250	260	255	270	280	280	295	260	290	305	350	450	560	740
B	Present altitude of the summit (closing) Iroquois = A plus F plus G	362	385	430	435	445	443	448	456	455	464	415	440	452	460	671	815	1,030
C	Altitude of Iroquois at time of extinction. = 290 feet	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290
D	Land uplift since extinction of Iroquois. Present height of the marine plane. = B minus C	72	95	140	145	155	153	158	166	165	174	125	150	162	170	381	525	740
E	Land uplift during Iroquois time, Glacial uplift. = A minus D	113	100	105	105	105	102	112	114	115	121	135	140	143	180	69	35	0
F	Rise of Iroquois level by flooding, south of Rome isobase, due to excess of rise at Rome. = 180 ft. minus E = B—(A + G) Splitting of beaches north of Rome.	67	80	75	75	75	78	68	66	65	59	45	40	37	0	62	35	0
G	Initial altitude of Iroquois. South of Rome isobase. = C minus 180 ft.; = B—(A + F) = B—(180ft. + D)	110	110	110	110	110	110	110	110	110	110	110	110	110	110	?	?	290
H	Present unlifted altitude of the initial Iroquois plane. South of Rome, = G plus A; = B minus F	295	305	355	360	370	365	380	390	390	405	370	400	415	460	733	850	1,030

FIGURE 7. *Tabulation of uplift data*

Altitude figures refer to ocean level. The figures in black face show actual measurements made in the field ing the interval between the two planes everywhere in the St. Lawrence and Ontario Valleys. Field measurements at many places confirm this theory.

This interval of 290 feet is the master key to the amount of glacial and post-glacial uplift, when used in combination with the isobases of total uplift, shown in figures 6 and 7. The lines of these maps give the total uplift during all of Pleistocene time, as the rise of the land did not begin, it is thought, until the latest ice sheet had melted off. If we know either the Iroquois or the marine altitude at any point we may obtain the other by subtracting or adding 290 feet. And knowing the figure for the total uplift of the station, found by scaling the maps, we can calculate two elements, first, the amount of uplift during Glacial (Iroquois) time, and second, the amount of rise during Post-Glacial (Post-Iroquois) time, or since the sea-level waters took possession of the Ontario basin. The latter figure is, of course, the uplift of the marine plane.

In the study of the levels of the glacial lakes another element is critical. It will be seen by the table that Rome, the point of outlet and control of Iroquois, was lifted 180 feet during Iroquois time, while Rochester and Charlotte were raised only 105 feet. But as the height of the lake outlet determined the level of the lake it is apparent that the greater rise of the land at Rome produced a rise of the water-level, or a flooding, at all points south of the Rome isobase. At Rochester and at Charlotte this flooding was about 75 feet. In the diagrams, figures 8 and 9, the amount of flooding is not conveniently separated from the rise of land; but the two taken together, land rise 105 feet and flooding 75 feet, make the total rise of the Iroquois water level, 180 feet.

This tabulation is deserving of careful study. It indicates that the land uplift was by a wave movement, progressive from south to north, or following behind the waning ice sheet, due to relief of pressure. It shows, also, that the rise in Iroquois time was proportionately greater on the south side of the basin, and decreases to zero at Covey outlet; while, on the other hand, the rise since Iroquois time, the uplift of the marine plane, increases toward the northeast to 740 feet at Covey pass. The table also gives the initial altitude of the Iroquois plane. The figure south of the Rome iso-

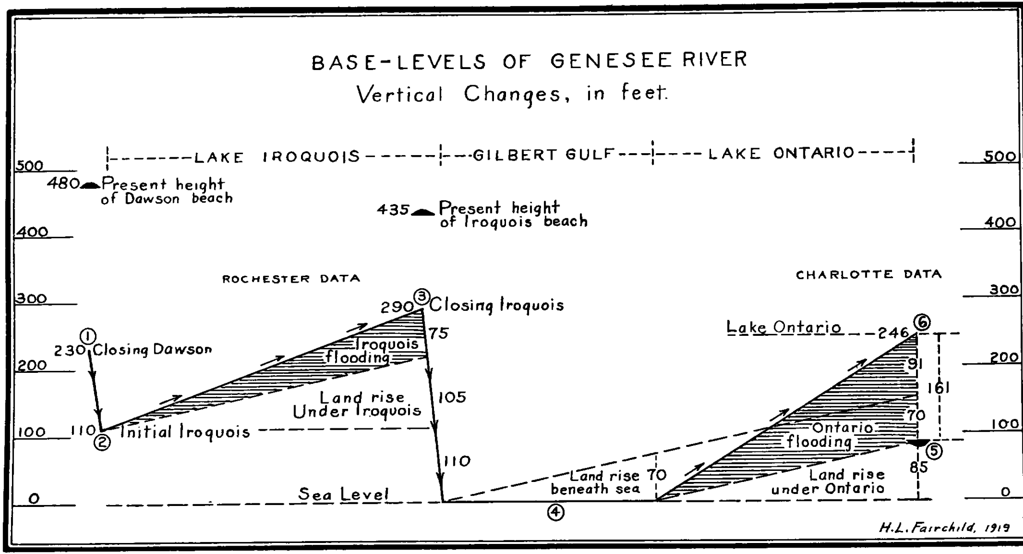


FIGURE 8. *Vertical Changes in the Genesee River Base-Levels*

base, 110 feet, is the intial height of the Iroquois plane at Rome, or in other words, it is the original altitude of the plane which is now raised up to 460 feet. But the actual water-level of the primitive Iroquois might have been somewhat lower, depending on some conditions at Rome and Little Falls. It must be understood that all figures in the tabulation refer to levels of the water planes, not of lake or river bottoms.

While the uplift at Rome, being more rapid than southward, produced rise of the water surface or flooding on the area south of the Rome isobase, the wave uplift of the land north of the Rome outlet raised the land out of the Iroquois water, and produced the vertical succession of beaches or gravel bars so conspicuous between Richland and Adams Center, and occurring as far as Malone. The vertical range of the bars, or "splitting" of the beaches increases from zero at Rome to 62 feet at Watertown, and from that district declines to zero at Chateaugay and Covey pass. The explanation for this fact is discussed in paper No. 29.

Vertical Changes in the Water Levels

Diagram, Figure 8.

The plotting in this diagram aims to show the up-and-down movements of the standing waters which served as the control, or base-levels, of the Genesee River in the Rochester district. The causes of these changes of level, land tilting and shifting of outlets, are not indicated. Merely the effects on the surface level of the river, at its mouth, are shown. The changes in horizontal position of the mouth of the river are not given, but this is suggested in the next diagram. The horizontal element in the diagram represents the time factor.

All altitude figures in this writing refer to ocean level. In the diagrams, figures 8, 9, the order of occurrence or succession of levels is indicated by the numerals in circles. Arrow points in figure 8 show the direction of movement. As already stated, the figures in this diagram, and in all the diagrams and table, are altitudes of water surface, not the floor or bottom of the channel. The depth of the river, or height above tide of the floor of the channel, can only be estimated.

The critical element in the study is the control of the water levels exercised by the outlets, on the northeast. For Iroquois this is known quite definitely; and precisely for Lake Dawson. For the initial Ontario we are not sure with precision. The control today, 246 above sea, is between Alexandria Bay and Brockville. But what we require is the point on the axial line of the St. Lawrence Valley which was first lifted out of the ocean-level waters (Gilbert Gulf), and which initiated Lake Ontario. We have learned from the tabulation, figure 7, that the land uplift was a wave movement, following the removal of the ice sheet, and hence somewhat earlier at the southwest than at the northeast; but greater in amount toward the northeast. From these facts it appears that the locality which first rose above the Gilbert Gulf waters, and became the sill or waste-wier for the outflow of the primitive Lake Ontario could not have been the place of present outflow, but was somewhat to the southwest. The controlling point was probably in the district of Alexandria Bay, or possibly yet farther this way. For the purpose of this study the primitive control of initial Ontario is taken on the isobase of Alexandria Bay, and the depth below the surface of Lake Ontario of the drowned mouth of the Genesee River depends on that point of original control, as will appear later in these pages.

The changes in the river level during Dawson and Iroquois times are quite clear. During Dawson time the altitude was about 230 feet (480 feet minus total land uplift of 250 feet). From this level the waters fell to the primitive Iroquois, to about 110 feet. Then the Iroquois level slowly rose, with the rise of the Rome outlet, to 290 feet. The rise of the land at Rochester was 105 feet during Iroquois time, and the flooding, due to excess of uplift at Rome, was 75 feet. This sequence of events in the history is proven by the position and character of the Iroquois beaches and deltas, as will be described later. An important fact to be noted is that the fall of the water level from 230 feet (Dawson) to 110 feet (primitive Iroquois) was relatively sudden, at least giving no chance for efficient wave work; but that the rise of Iroquois up to its extinction, 290 feet, was very slow, probably covering several thousand years, and permitting effective geologic work. The fall of Iroquois was, like that of Dawson, too prompt and continuous to allow the production of conspicuous shore features; but some deltas were built at intermediate levels in the courses of heavy streams from the Adirondacks.

The primitive Iroquois features must lie down the land slope, northward, from the "Ridge Road" beach, and the study of these early levels is transferred to Charlotte.

As already described, Lake Iroquois was extinguished by the melting away of the edge of the Labradorian ice sheet from the steep north face of Covey Hill, just north of the international boundary; and the water level in the Ontario basin became the ocean level. That ancient shore of the first sea-level waters is out one or two miles under the waters of the present Lake Ontario. Referring to the tabulation, figure 7, it will be seen that Charlotte has been lifted 155 feet since the close of Iroquois or beginning of Gilbert Gulf. As the present lake has been flooded, by the rise of its outlet, to 246 above tide it follows that the earliest marine beach is 91 feet beneath the waters of Ontario. This fact will be used later.

We must now study the Post-Iroquois history at Charlotte in connection with the land movement at the place of the earliest outlet of Lake Ontario. As stated above; this point is taken near the head of the St. Lawrence River, on the isobase of Alexandria Bay. The maps of isobases, figures 5 and 6, show that the total rise of that place has been about 500 feet. The uplift of glacial time is calculated as about 50 feet. This leaves 450 feet as the amount of rise at that point in Post-Iroquois time; or since sea-level waters were established in the Ontario basin. As the point (always water surface) has been raised 246 feet above the sea it follows that it was 204 feet beneath the sea at close of Iroquois time, or under Gilbert Gulf waters. Of course Lake Ontario was not initiated until that point was raised out of the sea. The relation of that event to the movement at Charlotte is the next problem.

While Alexandria Bay was rising 450 feet Charlotte rose 155 feet. We must now determine how much Charlotte rose while Alexandria Bay was rising in sea-level waters, or 204. By simple proportion we find this to be 70 feet (450; 155; 204, 70). By similar calculation we find that Charlotte has risen 85 feet during the life of Lake Ontario. Further we find that the excess of rise at Alexandria Bay has caused 161 feet of flooding at Charlotte (246 minus 85).

The uncertainty in these figures for Charlotte rests in the doubt

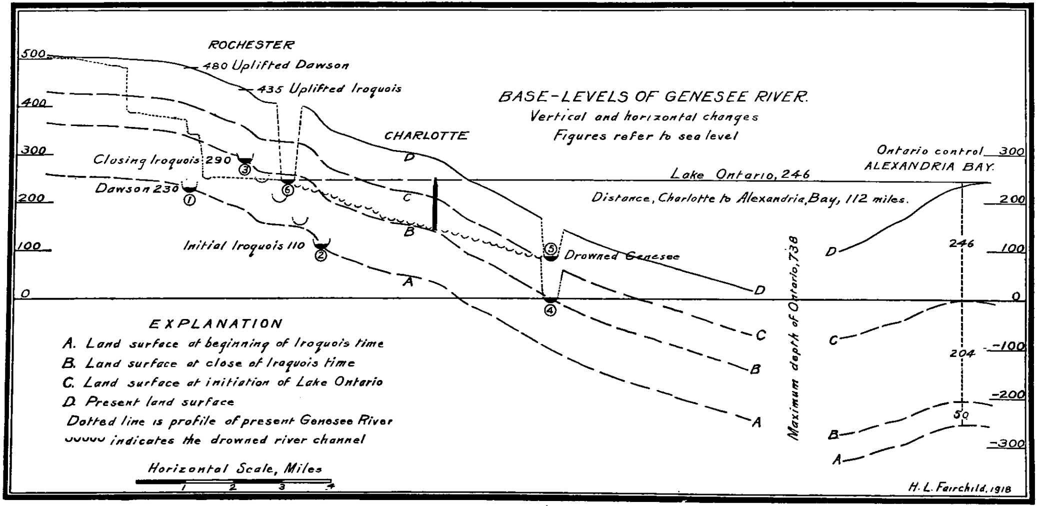


FIGURE 9. *Vertical and Horizontal Changes in the Genesee River Base-Levels*

as to the precise point at the head of the St. Lawrence Valley which first emerged from the ocean-level waters. For anyone who might like to follow this problem in more detail the following tabulation is inserted of the elements at Alexandria Bay and three other stations.

Station.	Total land uplift.	Uplift in Glacial time.	Rise beneath Sea.	Rise above Sea.	Post-Iroquois uplift.	Charlotte.		
						Rise under Sea.	Rise under Ontario.	Flooding of Ontario. Submergence of the Genesee.
Cape Vincent	450	70	134	246	380	55	100	146
Clayton	480	65	169	246	415	63	92	154
Alexandria Bay	500	50	204	246	450	70	85	161
Brockville ..	540	40	254	246	500	79	76	170

The interesting question now arises, where is the floor or bottom of the Genesee River, at Charlotte, as it existed during Gilbert Gulf time. The discussion of this interesting and practical engineering problems must be deferred until the next diagram in described.

Vertical and Horizontal Changes in Water Levels

Diagram, Figure 9.

The diagram should be compared with figure 8 and with the tabulated data, figure 7. This diagram is much exaggerated in the vertical as compared with the horizontal scale. It is intended to illustrate roughly how the mouth or debouchure of the Genesee River was shifted horizontally, up and down the land slope, as the water levels fell or rose.

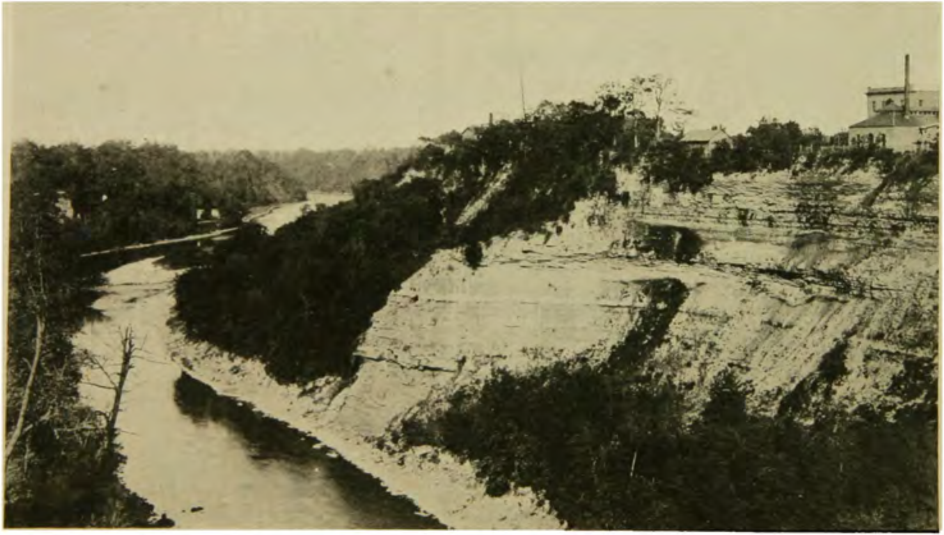
The apparent discrepancy between the amount of uplift at Rome and Alexandria Bay is explained by the fact that Rome lies much farther south, and the progressive land uplift lifted Rome earlier and in greater amount during Iroquois time. But on the other hand, Alexandria Bay was raised much more than Rome during Post-Glacial time.

When Lake Dawson was drained down 120 feet, vertical, the mouth of the Genesee was shifted northward, down the slope; along its present path between Lake Avenue and St. Paul Street, or from point 1 of the diagram to point 2. Subsequently, as the surface of Lake Iroquois rose, by the rise of the Rome outlet, the river mouth was slowly lifted through 180 feet, vertical, and shifted southward, up the slope, to the position of the Ridge Road; point 3 of the diagram. The water surface was then 290 feet above the ocean. All the figures in these diagrams refer to water surface.

The next change in water level was the relatively sudden drop of Iroquois to sea level, through 290 feet. During this episode the river mouth was rapidly shifted northward, down the slope, to some point north of Charlotte. The water surface, sea level, and the beach then had the position of number 4, on line B. But the land rise of 155 feet since the close of Iroquois has lifted the point on line B to line D, and the initial shoreline of Gilbert Gulf is now only 91 feet beneath Ontario.

During the life of Gilbert Gulf the river mouth was certainly fixed in vertical relation, its height being sea level. But during that time, we have found, Charlotte was lifted 70 feet. The question now arises, did the river mouth migrate northward, down the slope, as the land rose out of the sea-level waters, or did the river hold its sea-level position by the down-cutting of the river's bed? As the rock strata in the lower section of the canyon, and for some 800 feet downward, are chiefly weak red shales, and the land uplift was certainly slow, it seems quite certain that the river was able to intrench its channel, keeping pace with the rise of the land. This is the history indicated in the diagram. No horizontal shifting of the river's mouth during the life of Gilbert Gulf, needs to be recognized. It is impracticable to represent the relation of land movement and river channel further than is shown by the successive positions of the rising land surface, lines B. C. and D, and the profile of the present river bed, between points 6 and 5.

When Lake Ontario was initiated, by the lifting of the Alexandria Bay point of initial outflow above the marine plane, the north portion of the river canyon (now buried and drowned) had been intrenched, during Gilbert Gulf time, about 70 feet. Then the receiving waters began to rise, and of course the river level in accordance. That rise has been 246 feet, producing the present



ROCK STRATA, ROCHESTER CANYON
View looking north from Driving Park Avenue bridge

N. R. Graves, Photo.

THE ROCHESTER CANYON
View looking north, downstream, from near Driving Park Avenue bridge

relation of the lake, the river and the canyon. But while the lake rose 246 feet the land at Charlotte rose 85 feet, leaving 161 feet for the Ontario flooding. It will be seen, therefore, that the plane of the river surface, as it existed at the close of Gilbert Gulf time, is as much beneath the present level of Ontario as the height of the lake minus the rise of land since the lake was initiated. This is 246—85=161 feet. This depth of 161 feet is for the plane of the ancient river surface, not for the bed of the river. The rock bottom at the mouth of the drowned channel may be 10 to 20 feet lower, or 170 to 180 feet. The location of the mouth of the drowned channel is out in the lake about 2 miles from the present shore; but the channel is filled and obliterated by the drifting sand and silt in the lake.

It is not claimed that these figures are precise. They are certainly suggestive and quite certainly approximate. The exploration of the buried channel at Charlotte, described in the next chapter, confirms the accuracy of the calculations.

The reader may think that the history is complex and difficult to grasp. But it is as simple as will explain the known facts. It is possible that the actual sequence of events is even more complicated, as there might have been facors which are not yet recognized.

Channel Features at Charlotte

Diagram, Figure 10.

Fortunately for this study we have important and interesting data concerning the buried river channel at Charlotte, which confirm the conclusion derived from the geologic study. The engineering work on the new bascule bridge at Charlotte has determined the depth of the river silt and the position of the rock floor of the buried river channel at that point.

Through the courtesy of the County Engineer, Mr. J. Y. McClintock, and the help of Mr. Fred C. Line, Assistant to the County Engineer, who had immediate oversight of the caisson work, a diagram is here included, figure 10, showing a cross-section of the valley at the site of the bridge, and the facts, as far as the exploration now reveals, of the old river channel as it was cut during Gilbert Gulf time.

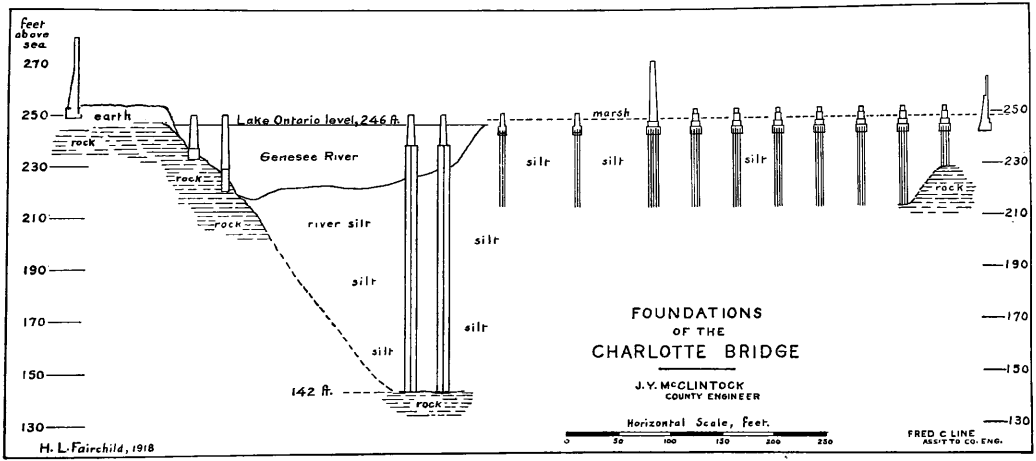


FIGURE 10. *Drowned Channel of the Genesee River*

The west piers of the bridge stand on the rock which makes the west bank of the river. The four east piers, 180 feet distant from the west piers, stand on rock at depth below the average river surface (246 feet) of 103.14 to 105.67 feet. The four caissons for these concrete piers explored the rock surface over a rectangle 38 feet north-and-south by 41 feet east-and-west. The variation from horizontality of the four surfaces uncovered by the caissons was two and one-half feet; and the differences do not indicate any definite direction of slope. The area covered by the exploration is probably too large to represent merely a shelf on the west side of a deeper channel, especially as the red shales are too weak to support wide terraces. It appears more than probable that we have here found the ancient channel bottom. This is now 142 feet above tide, and averages 104 feet below Ontario lake surface.

On the diagrams, figures 9, 11, the position of the east piers is shown. It will be seen that the piers stand on the theoretic line of the graded river channel. These diagrams were made before the data from the Charlotte bridge were used.

The Canyon History

Plates 4, 14. Figures 11, 12.

In the production of the canyon features two factors are concerned; the varying character and resistance to erosion of the rock strata, and the changing levels of the standing waters. The latter factor has already been considered, but the rocks must be briefly described.

The accompanying diagram, figure 11, gives the succession of strata, from the red shales at the bottom of the canyon up to the limestone that is the top stratum through the city, conspicuous at the upper falls and from Court Street bridge. These rocks are all of oceanic origin, having been accumulated as clay, sand or lime sediments in the shallow waters of an inland sea. We may liken the waters to the Hudson Bay or the St. Lawrence Gulf of the present time. In age the rocks are very old, dating from the ancient Silurian Period, as attested by the abundant fossils of salt-water origin found in most of the beds.

The important features of the canyon are of three classes:

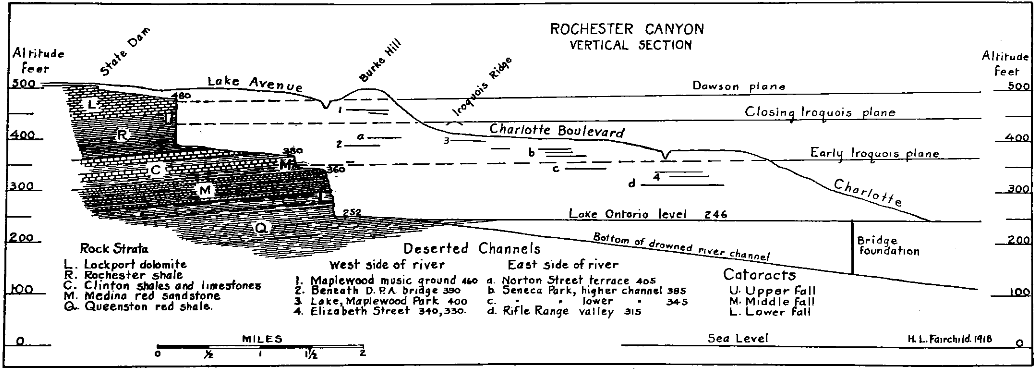


FIGURE 11. *Vertical Section of the Rochester Canyon*

(1) the cataracts; (2) the curvatures or meanders; and (3) the deserted channels or scourways on the sides of the ravine.

Cataracts

Cataracts and cascades are produced by unequal resistance of the rocks to the stream erosion. Vertical falls occur where strong or resistant beds cap or overlie weak beds. The upper fall is a good illustration of the vertical cataract, where we find the lower beds of the relatively hard Lockport (Niagara) dolomite capping the thin-bedded and weaker Rochester shales. The middle fall was due to the lower Clinton limestone overlying the weak Clinton lower shale (Maplewood green shale). The lower fall is not vertical, but a steep cascade, due to the thick and very hard beds of the Medina sandstone. The characters of the three falls are shown in the photographs, plates 4–14, and their relation to the water levels in the diagram, figure 11. It appears that the upper fall was no more than initiated in Dawson time; but was cutting during all of Iroquois time, and of course, during all later time. The middle fall was no more than started, if cut at all, in Iroquois time, as that plane was soon flooded by the rise in Iroquois waters. The lower fall is wholly post-Iroquois.

It must not be supposed that the several falls originated at the points where they now stand. In the development of the cataracts there has been migration, backward, up stream. They began as rapids or low cascades and were developed to their present height and form by the up-stream recession. It is not possible, nor very important, to locate the point of origin of the different falls. The southward dip of the strata, suggests that the point and plane of initiation of each cataract was somewhat higher than the present position, proportionate to the distance northward.

If the whole length of the canyon, from City to lake, had always been equally exposed to the air and river work the lower and northward part would have originated first and have deepened more rapidly, because the rocks toward Lake Ontario are only the very weak red shales. But in fact the northern, lower and deeper part of the canyon is youngest, dating from the close of Iroquois time. It was cut during Gilbert Gulf time. The upper part of the ravine, through the business portion of the city, is the oldest, beginning dur-the Dawson time.

The altitudes and heights of the falls are given approximately in the following table. Compare with figure 11.

GENESEE RIVER IN THE ROCHESTER CANYON

	Altitude at crest of falls.		Height of falls.	
	Topog. Map.	Roch. R. & L. Co's Survey.	Authority?	Roch. R. & L. Co's Survey.
Upper fall	480	—	92	—
Middle fall	380	370	28	31
Lower fall	360	341	96	89

Drop of the Genesee River in the three falls....................	216 feet
Drop of the Genesee River between the three falls	12 feet
Total drop, to foot of lower fall	228 feet
Drop of river beyond lower fall	6 feet
Total drop of river	234 feet
Elevation of Lake Ontario	246 feet
Altitude of crest of upper fall	480 feet

Deserted Channels and Meanders

Figure 12.

The erosional work of the river in the process of cutting the canyon is partially shown in the remnants of the abandoned channels or scourways that are now found along the sides of the canyon. These occur from the Dawson level down to near the Ontario level. They are not indicated clearly by the contours of the Rochester Sheet, but the more important ones are mapped in figure 12.

The largest, most evident and most interesting of the old river channels are those in Maplewood and Seneca Parks. These parks are located as they are because of the river work. The smooth, rolling tracts of ground now utilized for the pleasure of the people were shaped by the river during its erosion of the canyon. These are shallow troughs or flutings, or terraces and benches, carved in the rock strata, and with a down-slope always to the north.

The highest old river bed and bank correlates with the lowering Lake Dawson. It is seen on both sides of the canyon at Driving Park Avenue. On the east side it is the level stretch in the little park south of the avenue. On the west side it is all the ground of

UPPER FALL, GENESEE RIVER, ROCHESTER, N. Y.

N. R. Graves, Photo.

LOWER FALL, GENESEE RIVER, ROCHESTER, N. Y.

upper Maplewood Park. The slope of the rose garden and that used for seating in front of the Band Stand is the west bank of the old river. (Plate 9.) The altitude of these floors of the river channel is about or somewhat over 460 feet. We may call this the Upper Maplewood channel. When it carried the river it extended across from the west to the east bank, and there was no cutting below. This was the lowest point that the river had reached to that time.

Some 70 feet beneath the Upper Maplewood channel are conspicuous be ches in the canyon walls on which stand the abutments of the arch of the Driving Park Avenue bridge. The west terrace (see Plate 10) is the more prominent, and carries the concrete pavilion or shelter that stands just north of the bridge. This terrace is floored by the Clinton lower limestone (Reynales limestone of Chadwick). Its altitude is 390 feet at the south and 388 feet at the shelter. The corresponding shelf on the east side of the canyon is not conspicuous.

Passing north from the Upper Maplewood Park the successive work of the old river is seen in hollows and banks, declining northward and ending at the brink of the deep canyon. Along the Maplewood Drive a good, broad scourway lies at the junction of the Seneca Parkway, with altitude about 440 feet. The channel with clearest character on the west side is the one in Lower Maplewood Park, at the Ball Ground, Refectory and lake. The altitude here is 400 feet.

Since figure 12 was engraved Professor Chadwick has recognized another channel remnant in the lower Maplewood Park. This is a shelf, 110 feet wide and over 500 feet long, on the west wall of the canyon some 35 feet beneath the Refectory channel, noted above. This cutting is in Medina sandstone, with altitude about 365–370 feet. Making allowances for distance and grade it seems probable that the floor of which this shelf is a remnant correlates with the lower (Lake) channel in Lower Seneca Park, to be described below.

Going north on the east side of the canyon a broad scourway is found at the junction of Norton Street with the Seneca Park Drive. The latter parkway follows the terrace to the junction of the Brewer's Dock Road. The altitude is 405 feet. The locality was a part of old Carthage village.

FIGURE 12. *Deserted Channels of the Genesee River*

One half mile south of the main portion of Seneca Park a small channel occurs which the Park Drive crosses by a filling. The sharp cut behind a rock knoll is conspicuous; with altitude 385 feet.

Lower Seneca Park occupies two elegant old channels. To Professor Chadwick is due the credit of being the first observer to explore these deserted channels with recognition of their genesis and to appreciate their significance in the canyon history.

The lower and larger scourway is the one which carries the deer park, the music ground, pavilion and the artificial lake. This channel begins in a definite depression at the top of the east wall of the deep canyon, and leads northeast, curving to northward and widening. The banks are very evident, the west bank passing through the deer park and forming the slope on which are placed the benches for the concerts. (See plate 11.) The lake has been made by constructing a dam across the lower, northern, end of the channel. The features here deserve careful study.

The rolling plain in which the channel is cut has altitude about 350 feet. The floor of the channel is about 345 feet at the head and 337 feet for the lake surface. The theoretic level of the primitive Iroquois is 360 feet. As the erosional features are about the depth below the lake surface to which the vigorous river, provided with abrading materials, would erode its channel bed, it suggests that we have here the lake and river bottom of initial Iroquois. The bank by the Band Stand is rock, the soft, red Queenston shale. The width between the definite banks is over 500 feet; sufficient to carry the river. Gravel deposits are spread over the plain. As both ends of the channel are cut off by the east wall of the deep canyon it is apparent that the latter is later in time.

The lake channel is certainly stream work, and if not related to the early and lower level of Lake Iroquois then it must be attributed to the falling Iroquois. If the latter, it is difficult to understand why the river in its downcutting should desert this capacious channel and make the ravine on the west, in the same kind of rock. A better explanation appears in the view; that the plain and channel was primarily cut in early Iroquois time, following the downdraining of Dawson; that as Iroquois rose and the waters here deepened, the channel was buried in delta gravels; then when the lake finally fell away the river currents swept out the gravel and produced the present forms, while the main flow was on the west, beginning the ravine.

A higher and less capacious channel is utilized by the New York Central Railroad, and by the electric line into the Park. The terminal loop of the latter (incorrectly shown in the topographic map) is in the middle of the channel, at altitude about 380 feet. The tennis courts and animal enclosures are on higher eroded spaces along the west side of the railroad channel, at elevation about 385–390 feet. The Refectory stands on the west bank of this channel.

It should be clearly realized that when these Seneca Park channels were forming they were the lowest channel cut by the river, and that there was no canyon below the 337 feet floor. The detritus from the erosion of the channel and the upper part of the canyon, southward to beyond the upper falls, was contributing to the broad silt plains at Charlotte and Summerville, now lifted to 340–360 feet in altitude. As the Iroquois level rose the Seneca Park channels of the early cutting were buried in the delta deposits; but these were swept out later, when the Iroquois waters were drained down to sea level. The present form of these lower channels must be partially due to the river work during the falling away of the Iroquois waters.

In this brief description it has been assumed that the old channels were cut in succession from the highest to the lowest, but this may not be wholly true. The scourways have the form that would be expected of rapid flow for a brief period. The channels through Maplewood and Seneca Parks and lying beneath the level of the closing Iroquois (Ridge Road), fall within the range of three lake episodes, the falling Dawson, the rising Iroquois, and the falling Iroquois. During Iroquois time the river probably had time to intrench itself, so that during the rise from lower to higher levels the river was probably confined to its rock-walled canyon. It appears that during later or full-height Iroquois the water level extended south up the drowned canyon to the upper falls (see figure 11), and with such depth of water the lateral erosion must have been small.

There yet remains for description the lower part of the canyon, north of Seneca Park. The cemeteries, on the west side of the river, show only indefinite river work, in morainal deposits; for it

LOWER FALL, GENESEE RIVER, ROCHESTER, N. Y.
General view

must be understood that the glacier had left masses of drift on the old land surface, which the river encountered and had to remove in the canyon cutting.

The Rochester sheet and figure 12 show the channel features at the lower levels. The highest of these is the broad, fluted scourway on the west side of the canyon crossing Elizabeth Avenue. The altitude of this is 340 feet. It ends abruptly at the singular semicircular hollow or re-entrant in the canyon wall, one and one-half miles south of Charlotte. The remarkable curving channel, or meander, on the east side is over a mile long and one-third mile wide, with altitude under 320 feet. This curving hollow has been called "the flats," "sunken gardens" and "rifle-range hollow." It deserves a better name. The semicircular re-entrant in the west wall of the canyon is opposite the north and lower end of the east-side meander channel, which suggests that it was excavated, at least in part, by the impact of the river current that swept the meander. But as its swampy bottom is the present river level it seems probable that it has been partly excavated as a cataract of the small stream which flows north across Elizabeth Avenue.

The Elizabeth Avenue scourway and the meander channel do not correlate with any recognized water level. They are below the lowest Iroquois and much above the marine plane. Unless they are due to some unknown element in the history, which is possible, they probably represent a phase in the down-draining of Lake Iroquois. They would not require a long pause, or stand-still of the receiving waters, since they are cut in the soft deposits of the Iroquois delta. But the wide swing of the meander channel, with the island left at its center, deserves tentative explanation. This is about the locality where the Genesee River debouched into the early Iroquois lake. The fine river-borne detritus was swept far and wide by the lake currents, even to Irondequoit Bay. But the large volume of coarse material, derived from the cutting of the rock canyon, was dropped close by the river's mouth. During the lowering of the lake waters this mass of coarse detritus was for a time an obstruction to the direct flow of the whole river, and probably caused partial diversion, first by the Elizabeth Avenue course, and later through the meander channel. The island-like mass at the road corners contains much coarse material, representing either the coarse delta stuff or glacial drift, or both. Finally, with the lowering of the base-level waters and the increased velocity of flow the river was able to straighten its course and to intrench itself in the canyon.

The level of the meander channel, 300–320 feet, is also suggested in smooth stretches of silt plains east of Summerville and toward Sea Breeze, and at the east of Forest Lawn. These plains might have been shaped rapidly out of the fine silt of the delta fronts.

Sufficient pause in the falling of the sub-Iroquois waters might have been caused by some little hesitation or increased push of the waning ice margin on the north face of Covey Hill, which was the dam that held in the Iroquois waters.

The larger curves in the canyon, which appear in the maps, plates 2, 4, were probably initiated by inequalities in the land surface which the river discovered in its extension northward, during the fall of the lake waters from Dawson to Iroquois, through 120 feet.

Some minor re-entrants and salients along the sides of the canyon, which the map does not indicate, represent lateral cutting by the river in the soft rocks during times of sluggish flow. Undercutting of one of the soft shale members of the rock strata would bring down all the overlying strata. The more striking curves are seen looking north from the bridge at Driving Park Avenue. Plate 4 shows the point of rock projecting from the east wall.

Future intensive study of the canyon and the correlating features will doubtless add interesting details to this brief description; and perhaps will discover new elements in the history and new facts. The present account of the canyon history appears to be well attested by all observed facts. It may appear complicated, but any new discoveries can only increase the complexity. As stated in the introduction, the story is not simple and cannot be made easy reading for a sleepy hour.

The numerical data given in the above writing are subject to some future revision, when some one shall have made more intensive study of the Pleistocene features of the Rochester district. But the main facts appear certain and the Genesee River history must be substantially as here given and as depicted in the diagrams.

UPPER MAPLEWOOD CHANNEL, WEST BANK
Deserted bed of Genesee River. View looking north over the music ground and band pavilion

Associated Geologic Features

Plates 2, 3.

Waters Previous to Lake Dawson

This writing deals especially with the water bodies which touched the City of Rochester and which limited the flow of the Genesee River; and the history of the Rochester canyon. But there are a number of related geologic features not yet described; while the maps, plates 2 and 3, show some unrelated but very interesting phenomena.

It has already been stated, page 12, that Lake Dawson was a late member of a long series of glacial lakes in the Genesee drainage area; not only earlier in time but higher in altitudes (23). As three of these earlier water levels have left records on the Rochester and Macdon quardrangles, combined in the map, plate 2, they deserve at least brief mention. The fuller description is printed in papers number 14 and 23.

Lake Warren. The highest and oldest records of wave work on the map are of Lake Warren. These lie about the top of Baker Hill at elevation of 890–900 feet. Lake Warren was an extensive water body held up by the ice sheet. It occupied all of the Erie basin, part of the Huron basin and a strip of territory in New York. Its outlet was westward across Michigan, pouring into the glacial Lake Chicago, and finally to the Mississippi. When the south edge of the ice sheet receded from the high ground north of Batavia the Warren waters penetrated into central New York as far as the Syracuse district, forming a narrow strip of lake along the south face of the glacier, with southward extensions up the valleys of the lower Finger Lakes. Subsequently the ice front receded from the steep north-facing slopes in the Syracuse region and the lake found a new and lower escape eastward to the Mohawk-Hudson. Then the waters ceased to be "Warren." The falling waters, tending toward Lake Iroquois have been called the Hyper-Iroquois. Some of the earliest channels of the east-leading drainage have been mapped in paper 23. Lake Dawson was only the latest stage of the Hyper-Iroquois waters, and a very brief pause.

The wave-smoothed areas on Baker Hill are the most northerly inscription in New York of Lake Warren. The north shore of the lake was the front of the Labradorian glacier. As Baker Hill lies on the isobase of 235 feet it appears that the lake stood about 665 feet above the sea.

Lake Dana. This lake was the longest pause in the Hyper-Iroquois waters, the level being determined by the capacious channel leading east from Marcellus village. Description of the lake and outlet is given in paper 23.

The Dana wave-work records are much more abundant in our territory than the Warren, because they lie some 200 feet lower and with wider areas of drift for registering the wave action. The deltas occur especially on the southwest flank of Baker Hill, and wave-smoothed surfaces on the Mendon gravel hills. In general the Dana features lie along the south border of the map, with altitude at 700–720 feet. Lake Dana was extinguished when the waning glacier uncovered passes in the Syracuse district lower than the Marcellus escape, and it is probable that this took place when the ice front was lingering south of Fairport and Pittsford.

In the Niagara folio (31) this body of water is improperly called Lake Lundy.

Lake Scottsville. Eventually, by recession of the ice front in the Syracuse region, the waters of the Irondequoit and Genesee valleys were lowered to the level of the low pass at Victor. Either by the Victor control or the Syracuse control the waters certainly stood for a time at altitude below the Dana and above the Dawson. Sometime during this episode of uncertain control, and probably fluctuating levels, the Pinnacle kame-moraine appears to have been built. Some wave-smoothed areas in the Irondequoit Valley at about 600 feet and wide silted plains and clay-sand flats in Henrietta at 600 down to 500 feet must correlate with the Victor pass. When the ice front melted from the Fairport-Lyons valley then Lake Dawson came into existence.

Dawson Drainage Channels

The outlet channel of Dawson is mapped in plates 2 and 3, and needs no particular description. This great channel, which carried a river comparable to the St. Lawrence, and was actually the latter's predecessor, graded a path for railroads and canal, and is a part of the most favorable route of commerce between the Atlantic seaboard

ROCK TERRACE, WEST END OF DRIVING PARK AVENUE BRIDGE

Deserted bed of the Genesee River

and the upper Great Lakes and Mississippi Valley. The outflow of Lake Dawson helped to produce the commercial supremacy of New York State and City.

The drainage of Dawson, through Fairport, Macedon, Palmyra and Lyons, was not directly into Lake Iroquois, but into a shallow intermediate body of water that occupied the Cayuga-Montezuma depression. This glacial lake, hemmed in on the north by the waning front of the ice sheet, we may call Lake Montezuma. It had its outlet past Jordan, Memphis, Warner and Amboy, pouring into Lake Iroquois which then lay over the region of Syracuse and the present Onondaga Lake. Lake Montezuma was probably some 30 to 40 feet higher than Iroquois.

It is an interesting fact, illustrating the complexity of the history, due to the effect of land uplift, that at a later time all the Montezuma lowland and even the Dawson outlet channels east of Newark were flooded by the later and higher Iroquois waters. The lower surface shown in the map, plate 3, had its finishing touches given by Lake Iroquois.

The altitude of the bottom of the Dawson channel east of Fairport was about 215 feet, declining to about 140 feet at Lyons (see tables below). The delta sandplains built in the low areas at Lyons and southeast of Clyde, in the Montezuma waters, give us the approximate level of the Montezuma waters, which appear to have been about 145 feet; while the Iroquois waters farther east were about 110 feet. With the help of the map of isobases, figure 6, we are able to calculate approximately the height of the channels and deltas at the time they were formed. By deducting from the present altitude the amount of land uplift we find the altitude during Dawson time. Following are some estimates.

	Present Altitude.	Land Uplift.	Height in Dawson Time.
Dawson outlet; bottom of channel.			
Channel at Fairport	460	245	215
Channel at Macedon	450	245	205
Channel at Palmyra	440	250	190
Channel at Newark	415	250	165
Channel at Lyons	400	260	140
Channel at Clyde	400	270	130
Lake Montezuma.			
Delta southeast of Lyons	400	255	145
Delta southeast of Clyde	400	260	140
Montezuma outflow.			
Channel at Jordan	400	280	120
Channel at Memphis	408	285	123
Channel at Warner	400	285	123
Channel at Amboy	404	290	114
Primitive Iroquois; Syracuse district.			
Delta plain at Belle Isle	400	290	110
Delta plain under Syracuse	400	290	110

The above figures for the Post-Glacial land uplift are taken only in multiples of five. A more precise determination of the amount of uplift is impracticable.

The delta sandplain on which stands the City of Syracuse and the plains east and west of Onondaga Lake were probably mostly laid in the early Iroquois waters, and at about 110 feet above the sea. It will be noted that this is the theoretic initial plane of Iroquois, south of the isobase of Rome. See the tabulation, figure 7.

Dawson Extinction

Lake Dawson was drained down to the Iroquois level when the ice front thinned and melted back over the drumlin area in Wayne County, between the old channel described above and the Iroquois plain on the north. The maps, plates 2 and 3, show the more or less definite valleys between the drumlin hills, with southeastward direction, toward the old channel, or to the lowland between Lyons and Rose. These channels of the down-draining waters are too numerous and uncertain to map with channel convention without more careful field study. Apparently the drainage was distributed instead of being concentrated in a few large or conspicuous courses.

LOWER SENECA PARK CHANNEL, WEST BANK

Deserted bed of the Genesee River. View looking north over music ground and band pavilion

Dawson Plains

Lake Dawson was too short-lived to produce extensive and conspicuous sandplains. But in the narrow Irondequoit Valley about Bushnell Basin and south to Railroad Mills the inwash of detritus by Irondequoit, Allen and other streams was sufficient to build the narrow plains shown on the map. The higher and broader delta plains west of Railroad Mills and Fishers, at 580 to 600 feet, correlate with the Victor pass, and are credited to the Scottsville waters.

Another area of Dawson deposits are the rolling sand hills at and north of Pittsford and west of East Rochester (Despatch). The surface expression and composition of the knolls, with the enclosed basins or "kettles," indicate that these fine sands were laid down at the ice margin. The material was contributed in part by the outwash from the glacier. The latter origin appears certain for the high knolls, up to 480 feet, lying between the Rochester and Syracuse Electric R. R. and the New York Central R. R. Professor Chadwick has mapped them as an "esker fan." (32) The whole area may be regarded as kames, rather than land-stream delts, and more or less leveled by the Dawson waters.

The flats south and southeast of Brighton are mapped as Dawson, being under that level; but westward, at the Twelve Corners and south of the Pinnacle moraine, those rising above the theoretic Dawson plane must be credited to earlier waters, or to the early Dawson before it was adjusted to the eroded Fairport outlet.

Some small areas in Greece are outliers of the beach or else are wave-smoothed kames.

Early Iroquois Plains

It has been shown that the Dawson waters dropped away to the initial Iroquois too rapidly to leave any good record except the extinction channels in Wayne County. Even at the summit plane the Dawson beaches are weak. But, on the contrary, the rise of the Iroquois waters was slow, depending on the rise of the land at the Rome outlet. This slow lifting of the water surface, and of the zone of wave-work, gave opportunity for the production of the smooth, up-sloping plain characteristic of rising waters.

The earliest Iroquois deposits or delta plains were formed, naturally, at the primitive or lowest level of the lake; in the Rochester region at, or perhaps slightly above, 110 feet. The theoretic figures for the initial Iroquois at different localities in the State are given in figure 7, line "G"; and the present uplifted altitude of the same plane in line "H." South of the Rome isobase the latter is found either by deducting the amount of flooding from the present altitude of the highest beach, or by adding the total uplift of the station to the initial Iroquois altitude (110 feet). North of the Rome isobase the height at which the Iroquois water reached the station is indeterminate. There the vertical range of "split" beaches, shows excess of land uplift over rise of water, after land uplift began, and the higher beaches are the earlier.

It will be seen that at Rochester and Charlotte the present theoretic height of the early plains. uplifted, is 360 and 370 feet. The earliest widespread lake deposits would naturally lie 10 to 20 feet below the water surface as long as the material was fine enough to be carried into quiet water, or the currents strong enough to distribute it. When the sandplains at Charlotte are examined, with the topographic map, it is found that the plain, with a rather abrupt north border, has height at the margin of about 340 feet. On the east side of the river the broad lower plain is 360 feet. On both sides of the river the plains rise steadily, with no bars or cliffs, southward to the base of the beach ridge, at about 420 feet. The smooth surface of the plains, with no bars, but with gentle rise toward the closing beach, is the character to be expected in a broad deposit made in rising water. If made in lowering level, such a wide plain, with decline of 80 feet would demand very slow change in water level, with the production of deserted bars of wave construction, or cliffs of wave erosion. Close-set bars are the common feature on shores of relatively falling water, like the splendid series of bars on the Iroquois shore between Richland and Adams Center. The subordinate bars or swells on the flanks of the main ridge on the southern shore of Iroquois, (see plates 2, 3) were formed as off-shore bars, similar to those now forming along the shore of Lake Ontario, and lay in water less than 20 or 25 feet in depth.

The early plains of the lower Iroquois are indicated on the map by oblique-line convention. On account of the land uplift being

LOWER IROQUOIS PLAINS, IN IRONDEQUOIT
Upper view, looking west from west edge of Durand-Eastman Park
Lower view, looking north over sewage disposal plant

greatest in direction 20° east of north the present, uplifted, altitude of the early deposits falls off to the west and rises toward the east. The approximate present height of the early water surface is given in the tabulation, figure 7. line, "H." The surfaces of the sandplains are below these figures, as the plains were not built up to the water level.

The remarkable sand plain in Irondequoit town, lying between the Genesee River and Irondequoit Bay, now deeply dissected by the numerous small streams flowing lakeward, has long been recognized as the delta of Genesee River built in Lake Iroquois. The deposit is finely laminated sand or clayey sand (silts), indicating quiet waters, which must therefore have been deep enough to escape vigorous wave action. Any earlier and coarser detritus is buried under the later and finer sediment. This delta plain is now so eroded that people often speak of the area as "hilly," but it is a district of "valleys," excavated in a plain. The summits of the ridges between the hollows are flat-topped and uniform in height east-west, as may be well seen anywhere in the Durand-Eastman Park. It is not correct to term the valley-slopes "hills." (See plate 12).

The surface of the Irondequoit delta plain rises from about 340 feet near Lake Ontario to 420 feet along the north flank of the Ridge Road gravel ridge. The greater mass of this delta plain must have been accumulated during the earlier portion of Iroquois time. The river then had its heaviest burden of detritus, for the reason that the land surface with its sheet of loose glacial drift was then freshly exposed, with no protective mantle of vegetation as in later time; moreover the river was then excavating its valley in the soft lake deposits, and a considerable part of the Rochester Canyon was then being cut but subsequently flooded by the rising lake waters. Some contribution to the plain, in diminishing amount, must have been made during all Iroquois time, as the volume of the river and wind-produced currents were sufficient to carry fine, suspended silt far out in the lake. But such fine material was not large in relative amount, and the coarser material as sand and gravel that was pushed along by the river was probably brushed shoreward by the deeper wave work and now constitutes the massive beach ridge.

A pertinent question is, why the delta plain is so much more extensive east of the river than on the west? In brief the reply is that it was the effect of prevailing westerly wind and the volume of suspended detritus. This involves some meteorology, and a fuller explanation is needed. As wind directions in this latitude are chiefly controlled by the passage of cyclones the most effective winds are from the west and northwest, following the storms; and this is when the river is running muddy. Today when the river is muddy the discoloration of Lake Ontario is much more often to the eastward. The great atmospheric currents were doubtless the same in the Glacial Period that they are at present. During the life of Lake Iroquois the suspended silt were mostly swept eastward. The fine texture of the upper silts may be observed in any excavation in the Park or at Sea Breeze.

The frontal portion of the delta plain appears to have been partially destroyed, for the southward curvature or concavity of the shore between Summerville and Forest Lawn is probably due in part to wave-erosion of the finer and weaker marginal deposits.

Early Iroquois Deposits East and West of the Rochester District

Plate 2.

In the belt of country between the Iroquois beach (Ridge Road) and the shore of Ontario,—the "Niagara-Genesee prairie,"—is a peculiar relation of surface deposits which is now explainable. The farmers have long recognized three soil belts in this plain. Immediately north of the Ridge Road, after the beach sands are passed, is a smooth belt, about a mile wide, of thin, hard, heavy, stony soil, often with rock near the surface. Beyond this belt of poor farming land is a belt of varying width of level sands, which near the stronger streams are conspicuous plains. This is recognized as an orchard or peach belt. Northward to Lake Ontario is the stretch of general farming, where the soils are chiefly glacial drift or till, with rolling or irregular surface.

The explanations of this belted country is now clear. The northern belt of drift soils with good agricultural quality was under such depth of Iroquois water as to be little affected by either wave-work or deposition of detritus. Here there is little evidence of

HIGHER IROQUOIS FEATURES, BY ALLEN CREEK

Upper view, Iroquois shore-cliff, by Linden Road

Lower view, later Iroquois plain, on north side of Corbett's Glen, 420 feet standing water. The sand belt includes the deltas of the streams which poured into the early and lowest Iroquois, when the streams had their heaviest load of detritus. In other words this belt represents the primitive level of Iroquois which received the contribution of the copious primitive drainage. With the rise of water level, due to the lifting of the Rome outlet, the delta sands were submerged and protected. The belt facing the Ridge Road was smoothed by wave erosion and transportation of the rising waters.

During the early stage of the Iroquois waters the wave-work was relatively weak, because the waters were newly imposed on an irregular land surface where the waves and shore currents were impeded; and the ice front on the north was near, giving only a narrow belt of open and shallow water. With longer life the rising waters overcame these inhibiting conditions; the glacier front had receded northward, and the wave work had levelled the drift knolls and straightened the shoreline. The wave-smoothed belt adjacent to the Ridge has a vertical range of 40 to 60 feet. Over this stretch the effective wave work, always landward, in the steadily rising water, continuously swept the bottom and pushed the sandy detritus southward as a migrating beach and finally left it in the massive gravel and sand ridge of the Ridge Road.

These sandy plains of the intermediate belt of the Niagara-Genesee "prairie" may be observed along the larger creeks. We may note; on Johnson Creek at North Ridgeway; on Oak Orchard Creek at Kenyonville and Waterport; on Sandy Creek at Kendall Mills. Three-fourths of a mile south of Kendall Center the sands form a belt less than a mile wide. In general the sandy plain may be found along the contour of about 360 feet; and better developed along the streams.

The "Newfane" beaches (31) in Niagara County, towns of Wilson, Newfane and Somerset, at altitude 360 feet or higher, represent intermediate levels in the rising Iroquois.

Eastward from Irondequoit Bay the belt of sands is not so distinct, because the area of northward drainage is small and the stream deposits less in volume; but the sands are recognized southeast of Forest Lawn; north of Webster; at Lakeside; at Furnaceville; between Pultneyville and Williamson; north of Sodus; and in the low ground south of Sodus Bay. The north border of the eastern belt is theoretically about 340 north of Webster, rising to 370 or 380 at Wolcott.

In the wide depression of Sodus Bay, reaching south to Clyde, are the most extensive Iroquois flats, shown as the white spaces in the map, plate 3. These silted plains are mostly 400 feet, and thus far below the summit Iroquois. The spreading and smoothing of the materials must have been by the wave action of the early or middle stages of the lake.

Later Iroquois Plains

Detrital plains built up to near the surface level in the higher stand, and during the closing phase of Iroquois, are prominent only in two deep embayments of the lake, the Irondequoit and the Sodus valleys. As the rising waters abandoned the deposits of the earlier stage, leaving them submerged and thus protected, the wave work swept most of the coarser detritus southward into the summit beach ridge, as noted above. But in the secluded embayments of shallow yet quiet water the inflowing streams built plains at near the water surface. In the Irondequoit valley the contributing streams were Irondequoit Creek, Allen Creek, Thomas Creek and other small streams. The summit plain has its most southerly point a mile northwest of Bushnell Basin, this being about the area of Mr. A. M. Stewart's farm. The altitude is about 425 feet. The layer of cemented gravel, about two feet thick, exposed by excavation in the north end of the esker, by the Palmyra road crossing of the electric railway, appears to have been an effect related to the Iroquois lake surface.

There is no definite northern limit of the higher plain, as it shades into the the extensive plain outlined by the 400 feet contour both sides of the Irondequoit Valley. This widespread sandplain is the most important and interesting topographic feature in the valley. Its altitude by the Ridge Road is 400 feet, and is there 35–40 feet inferior to the closing level of the lake. Southward the plain rises to 420 feet at East Rochester (Despatch). It should be noted that while the land has received a northward uptilt of toward two feet per mile since Iroquois time yet the plain declines northward. Evidently its original northward decline was more than at present. As the wave-base, or the depth reached by wave

G. H. Chadwick, Photo.

THE ROCHESTER CANYON

View looking south, upstream, toward the city. The river at level of Lake Ontario, 246 feet agitation, could not have been over 20 or 25 feet, it appears that the portions of the plain either side of the bay do not represent much accumulation by the higher waters but must be credited to the earlier stages. East and southeast of Brighton the plain is higher, and the delta of Allen Creek, at 420 feet, was about the water level. The village of Penfield stands partly on the summit plain, the corners, at 429 feet by the map, being about the waters edge. In a generalized way the features are indicated on the map, plate 2. The limitation between earlier and later Iroquois deposits, shown in the conventions of the map, is somewhat arbitrary.

South of the bay and Float Bridge road the valley was entirely filled up to the 400 feet level. The proof of this is found in the flat-topped remnants of the plain, now out in the midst of the eroded valley, but constructed of horizontally-bedded fine silts.

The complex history of the Irondequoit Valley and its deposits has been described with more fullness by Professor Chadwick in a former paper by this society, and the reader is referred to that writing, number 32 of the appended list.

Glacial Features

The purpose and plan of this paper do not cover the whole of the glacial history nor include the phenomena produced directly by the glacier itself. But two classes of features, the drumlins and moraines, are so prominent on the map that a brief description may by appropriate.

Drumlins.—The Palymra-Clyde district, plate 3, is the heart of the most remarkable drumlin area in the world. These singular oval hills are not rock but compact till. They were built up and shaped beneath the ice sheet by the transporting and rubbing action of the ice itself. They are heapings of the subglacial and englacial drift. The drumlins of western New York have been described and the mechanics of their origin discussed in a former article.*

At Sodus village and eastward the map shows how the waves of the later Iroquois beat against the drumlins along the north border of the drumlin belt, producing a line of wave-cut cliffs and correlating wave-built gravel bars. This line of cliffs and bars was not

* In the Bulletin of the New York State Museum, No. 111, 1907; also in the Bulletin, Geol. Soc. Amer., vol. 17, pp. 702–706.

the actual shore of the lake, for the waters penetrated between the hills over the lowlands; extended up the old Dawson outlet channel as far as Newark; and reached southward over the Montezuma plains into the Cayuga Valley.

Moraines. While the drumlins are subglacial, having been constructed under several hundred feet of ice, and therefore some miles back from the glacier margin, the moraines were laid at the ice margin in the open air. On the map, plate 2, the prominent moraines are the Pinnacle Hills; the Mendon Ponds area; and in the upper Irondequoit valley, from Bushnell Basin to Fishers. The remarkable group of high hills between Fairport and Victor, the so-called Turk and Baker hills, appear to be partly drumlin, partly moraine. If they have any rock core it has not been found.

All these moraines are largely gravel and sand, the product of glacial stream outwash. Technically the gravel knolls are termed kames, and these masses of terminal or peripheral drift are termed kame-moraine.

The Mendon kames are very striking, and with the two partly-buried eskers (33) form a most interesting geologic feature. A westward extension of the Mendon kame-moraine is found in the scattered drift, giving irregular surface, between the Mendon knolls and the Genesee River. The 20-feet interval between the map contours does not properly recognize or show the morainal surface.

The most interesting moraine to Rochester people is the range of hills along the southern part of the city, known as the Pinnacle Hills. As a definite, bold range it extends from Brighton to the Genesee River, and an extension of the terminal moraine belt occurs west of the river, along Brooks Avenue and south of Lincoln Park, reaching past Churchville and Holley to Albion. The moraine is properly called the Albion-Rochester moraine. It marks a line of readvanced position of the oscillating ice front, during the waning of the glacier and the general recession of the ice margin. The moraine has been partially described in two former articles, numbers 12 and 25.

A complication in the glacial lake history of the Rochester district is registered in the structure of the Pinnacle Hills. The lower portion or base of the hills, up to or over 600 feet, is horizontal sands. This base was laid in standing water higher than Lake

Dawson and earlier. This implies that either the Fairport pass was yet closed by the ice sheet or that the waters were held up by ice-front control in the Syracuse district.

When the lower or basal portion of the hills was laid the ice front was backed away, northward, some small distance. But the higher materials of the hills are largely till, or ice-laid, which proves the later presence of the glacier front, and therefore a re-advance of the ice front. In places, as south of Brighton along the Winton Road, the till charged with a multitude of large bowlders may be seen capping the fine, horizontal sands. The latter in some sections, like the cut at South Clinton Street, has been so pushed, mashed and kneeded by the overriding ice as to show none of its originad bedded structure. We have here positive evidence of some oscillation of the ice front; a backing away, by melting, of the edge of the ice sheet to some uncertain, but probably small, distance north of the line of the hills; deposition of fine sands, from the glacial outwash, in the waters leaving the ice front; then re-advance of the ice, with overriding of the lake deposits. Blocks of local limestone, plucked from the Rochester plain, are seen on the very top of the Pinnacle, having been lifted over 240 feet. Evidently the ice front then stood at the readvanced position for some time, permitting the piling of the hills of gravel at the mouths of the streams emerging from the glacier. Such oscillation of the glacier margin is thought to characterize the waning stage of continental glaciers.

The structure of the Pinnacle Hills, their position, and their peculiar relation to the general topography of the region, suggest a complication in the history of the Rochester region which needs further study.

As the only heights giving commanding views of Rochester City, and with the unusual character and geologic history, the whole Pinnacle Range should have been incorporated in the city's park system, and so preserved for the scenic and educational value. Fortunately most of the higher parts are now so occupied as to be preserved from destruction, but the highest point, the "Pinnacle" is yet outside the city and not secure. Some interesting sections have been destroyed for their gravel and others graded for building lots. The "Pinnacle" especially, should be made a public park for the people of all the future.

Kettles. The singular basins or bowls, called "kettles" in geologic parlance, are impossible effects of surface drainage and are attributed to late melting of buried ice blocks. Detached or isolated masses of the stagnant ice margin became so buried in the drift that they sometimes persisted for centuries or even thousands of years, outlasting the waters which may have covered their sites. When the ice blocks did finally melt the slumping of the drift cover and surrounding materials produced the depressions. They are handsomely represented in the Pinnacle range; in Reservoir Park; between South Clinton Street and Goodman Street; and especially in Mount Hope Cemetery. The Mendon kame area and the district of Bushnell Basin show even more and larger kettles. The reader is referred to papers 13, 16 and 28.

Eskers. These are singular ridges of gravel which were accumulated in the beds of rivers flowing beneath the glacier. The nearest one to Rochester is the bold, high gravel ridge two miles southeast of Pittsford which the electric railroad skirts on the east side. They are perhaps the most peculiar and anomalous features produced by glaciation. Those of western New York have been well described and mapped by Professor Giles in a paper by the Academy, number 33 in the following list.

Gilbert's Story of Niagara

The first geologist to appreciate the complexity of the Pleistocene history of the Ontario basin was Grove Karl Gilbert.* As early

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* By birth and education Mr. Gilbert belonged to Rochester. His father was the eminent portrait painter, Grove S. Gilbert. In 1862 he graduated from the University of Rochester, after which for five years he assisted Henry A. Ward in the Ward Museum. The Ward Collections in Geology, which became the Museum of the University, bear his pen work on many thousands of the labels. After two years on the Ohio Geological Survey he was, from 1871, continuously attached to the national geologic survey until his death, May 1, 1918. He was universally recognized as one of the great geologists of the world. A brief memoir was printed in Volume 5 of these Proceedings, pages 251–259. More extended memoirs, with bibliography, will be published in the Bulletin of the Geological Society of America, and in the Proceedings of the National Academy of Sciences.

When the American Association for the Advancement of Science held its annual meeting in Rochester, in 1892, Mr. Gilbert was selected by the Rochester Academy of Science to give the public lecture complimentary to to the Association. The model of "Coon Butte" (now the Meteor Crater) which he used in illustration on that occasion, is in the University Museum. The University gave him the degree of LL.D. in 1898.

as 1885 he recognized the three factors; (a), the damming effect of the waning glacier and the glacial-lake character of the earlier waters; (b), the succession of water levels due to opening of different outlets or places of escape for the impounded waters by the recession of the glacier front; and (c), the dislocation and canting of the water planes by the tilting uplift of the land. In 1890 his important and very interesting paper was published which is here listed as number 2 of the bibliography. This writing had special reference to the history of the Niagara River; but Niagara is a sister of the Genesee, and their histories are comparable in all essential elements; while the receiving water-levels were identical.

It is thought desirable to reproduce here one of Mr. Gilbert's diagrams and some parts of his description. The presentation of the essential facts in his clear diction will help the reader to grasp the complex geologic history. While his quantitative data are not precise (and were not meant to be exact) they are very good considering his work as a pioneer.

"The waves of the new-born Lake Ontario (Iroquois) at once began to carve about its margin a record of its existence. That record is wonderfully clear, and the special training of the geologist has not been necessary to the recognition of its import. The earliest books of travel in Western New York describe the Ridge Road, and tell us that the ridge of sand and gravel which it follows was even then recognized by all residents as an ancient beach of the lake. In the Province of Ontario the beach was examined and described by the great English geologist, Charles Lyell, during his celebrated journey in America, and afterward received more careful study by Mr. Sandford Fleming, and by the geologists of the Canadian Survey. In western New York it was traced out by the great American geologist, James Hall, during his survey of the geology of the fourth district of the State. Within a few years more attention has been given to detail. Professor J. W. Spencer has traced the line continuously from the head of the lake at Hamilton past Toronto, Windsor and Grafton to the vicinity of Belleville, beyond which point it is hard to follow. South of the lake, I myself have traced it from Hamilton to Queenston and Lewiston; thence to Rochester, and all about the eastern end of the basin to Watertown, beyond which point it is again difficult to trace. Southeast of the present margin of Lake Ontario there was a great bay, extending as far south as Cayuga Lake, and including the basin of Oneida lake, and it was from this bay that the discharge took place, the precise point of overflow being the present site of the city of Rome. For this predecessor of Lake Ontario Professor Spencer has proposed the name of Iroquois." (2, pages 67–68).

"The Ontario basin has been subjected to a very notable change of attitude, and the effect of this change has been to throw the ancient shore-line out of level. When the shore-line was wrought by the waves, all parts of it must have lain in the same horizontal plane, and had there been no change in the attitude of the basin, every point of the shore-line line would now be found at the level of the old outlet at Rome. Instead of this, we find that the old gravel spit near Toronto—the Davenport ridge—is forty feet higher than the contemporaneous gravel spit on which Lewiston is built; and at Belleville, Ontario, the old shore is 200 feet higher than at Rochester, N. Y.; At Watertown 300 feet higher than at Syracuse; and the lowest point, in Hamilton, at the head of the lake, is 325 feet lower than the highest point near Watertown. From these and other measurements we learn that the Ontario basin with its new attitude inclines more to the south and west than with the old attitude.

The point of discharge remained at Rome as long as the ice was crowded against the northern side of the Adirondack mountains, but eventually there came a time when the water escaped eastward between the ice and the mountain slope.

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An attempt has been made in Pl. III., to exhibit diagramatically the relations of ice dams and basin attitudes to one another and to the river. (Niagara). The various elements are projected, with exaggeration of heights, on a vertical plane running a little west of south, or parallel to the direction of greatest inclination of old water-planes. At N is represented the Niagara escarp-

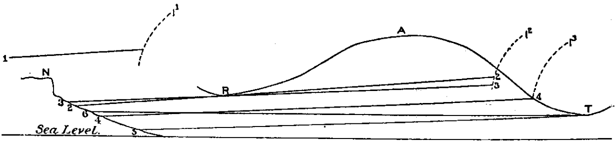

PLATE III.—Diagram to illustrate the relations of Water Levels in the Ontario Basin to attitudes of the land and to outlets.

FIGURE 15. *Gilbert's Diagram of Tilted Water Planes*

ment and the associated slope of the lake basin; At A the Adirondack mountains. R and T are the passes at Rome and at the Thousand Islands. Successive positions of the front are marked at I^1, I^2 and I^3. The straight line numbered 1 represents the level of lake water previous to the origin of the Niagara river; 2 gives the first position of the water level after the establishment of the Rome outlet; and the level gradually shifted to 3; 4 is the first of the series of temporary water levels when the water escaped between the mountain slope and the ice front; 5 represents the first position of the water level after the occupation of the Thousand Island outlet; and 6, the present level of Lake Ontario." (pages 68–70).

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"It is easy to see that these various changes contribute to modify the history of the Niagara river. In the beginning, when the cataract was at Lewiston, the margin of Lake Ontario, instead of being seven miles away as now, was only one or two miles distant, and the level of the water was about seventy-five feet higher than at present. The outlet of the lake was at Rome, and while it there continued, there was a progressive change in the attitude of the land, causing the lake to rise at the mouth of the Niagara until it was 125 feet higher than now. It fairly washed the foot of the cliff at Queenstown and Lewiston. Then came a time when the lake fell suddenly through a vertical distance of 250 feet and its shore retreated to a position now submerged. Numerous minor oscillations were caused by successive shiftings of the point of discharge, and by progressive changes in the attitude of the land, until finally the present outlet was acquired, at which time the Niagara river had its greatest length. It then encroached five miles on the modern domain of Lake Ontario, and began a delta where now the lead-line runs out thirty fathoms.

While the level of discharge was lower than now, the river had different powers as an eroding agent. The rocks underlying the low plain along the margin of the lake are very soft, and where a river flows across yielding rocks, the depth to which it erodes is limited chiefly by the level of its point of discharge. So when the point of discharge of the Niagara river—the surface of the lake to which it flowed—was from 100 to 200 feet lower than now, the river carved a channel far deeper than it could now carve. When afterward the rise of land in the vicinity of the outlet carried the water gradually up to its present position in the basin, this channel was partly filled by sand and other debris brought by the current; but it was not completely filled, and its remarkable present depth is one of the surviving witnesses of the shifting drama of the Ontario. Near Fort Niagara twelve fathoms of water are shown on the charts." (pages 70–71).

Note.—The writer makes grateful acknowledgment of assistance from many friends; especially from Professor George H. Chadwick for helpful criticism and suggestion, and to Dr. E. B. Angell, Cogswell Bentley, Ralph Boardman, W. H. Boardman and J. Foster Warner for transportation in the field study.

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In the following list of published writings which have some bearing on the Pleistocene geology of the Rochester district, a few papers may be noted as specially describing certain features

Earth movement, 3, 6, 7, 26, 29, 30; Water levels, 19, 20, 23, 27; Lake Iroquois, 2, 9, 10; Marine level, 20, 28, 29, 30; Irondequoit Valley, 13, 17, 32; Pinnacle Hills, 12, 25; Moraines; kames, 12, 13, 25; Drumlins, 21; Eskers, 13, 33; Kettles, 16, 28.

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MINERALS IN THE NIAGARA LIMESTONE OF WESTERN NEW YORK

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CONTENTS

Introduction *

The minerals occurring in the Niagara (Lockport) limestone of western New York have long been of great popular and scientific interest because of their variety, beautiful crystal forms, and abundance. Many of the species were described long ago by James Hall; and the literature of later date contains numerous references to the Niagara minerals, however the descriptions of Hall remain still among the best and most complete. The object of this study was to bring together all of the published material bearing on the

* The author wishes to express his indebtedness to Mr. Jacob Schuler of Rochester for the loan of his extensive and excellent collection of minerals from the Rochester region; and he desires to acknowledge his obligation to professors H. L. Fairchild, T. L. Watson, and G. H. Chadwick for suggestions and criticism which have been fully utilized in the progress of the study.

subject of Niagara minerals, and to add the facts and data that are new. The present seems a very appropriate time for this study, for recent excavations for the barge canal and building sites have revealed a wealth of material. It is hoped that this paper will serve as an incentive to the people of western New York who are scientifically inclined to make collections of these minerals. Such collections will further increase our knowledge of the minerals and, when brought together in course of time, will constitute an extensive and complete collection of the minerals of a region that has become classic in American geology.

List of Minerals

Name	Composition	Crystallization
Anhydrite	$CaSO_4$	Orthorhomic
Aragonite	$CaCO_3$	Orthorhombic
Barite	$BaSO_4$	Orthorhombic
Calcite	$CaCO_3$	Hexagonal
Celestite	$SrSO_4$	Orthorhombic
Chalcopyrite	$CuFeS_2$	Tetragonal
Dolomite	$CaMg(CO_3)_2$	Hexagonal
Fluorite	CaF_2	Isometric
Galena	PbS	Isometric
Gypsum	$CaSO_4 . 2H_2O$	Monoclinic
Magnesite	$MgCO_3$	Hexagonal
Malachite	$CuCO_3 . Cu(OH)_2$	Monoclinic
Marcasite	FeS_2	Orthorhombic
Pyrite	FeS_2	Isometric
Quartz	SiO_2	Hexagonal
Rutile	TiO_2	Tetragonal
Siderite	$FeCO_3$	Hexagonal
Sphalerite	ZnS	Isometric
Strontianite	$SrCO_3$	Orthorhombic
Sulphur	S	Orthorhombic

Manner of Occurrence

The minerals are found completely or partially filling solution cavities in the limestone, lining the walls of cavities and forming beautiful drusy surfaces, cementing breccia fragments of the limestone (8) and partly or wholly filling joints and other cracks penetrating the limestone. Beautiful geodes with their interiors lined with perfect crystals occur, but are rare. Certain minerals have also replaced the limestone, in some cases extensively, and other minerals are found on the exposed surfaces of the rock. Fossils have been found completely replaced and in many the interiors are filled with crystals. Large areas of the limestone have been recrystallized, forming cleavable mineral masses.

Important ore minerals, such as galena and sphalerite, are of common occurrence in the Niagara limestone, but they are too widely disseminated and too small in amount in this formation to be of economic importance.

Description of the Minerals

In the following descriptions the minerals are divided into two groups,—those of major importance being described first. In both groups the minerals are described in the order of their importance in the formation.

Minerals of Major Importance

CALCITE

Importance.—Calcite is the mineral occurring most abundantly in the Niagara limestone.

Form *—The commonest crystal form is the rhombohedron, generally acute. These crystals are small, in fact many are so minute as to be seen distinctly only with the hand lens. From this extreme they range up to forms that measure nearly an inch along the edges. Many of the acute rhombs exhibit rounded edges, and some of the larger acute rhombs have been formed by the oscillatory combination of smaller rhombs. Many of the smaller obtuse rhombs closely resemble cubes. Very acute rhombs terminated by the basal pinacoid, positive and negative acute rhombs in combination, and acute rhombs modified by the scalenohedron, are combinations that occur but are not common.

Contract rhombohedral twins, twin planes $(01\bar{1}2)$ and (0001), are sometimes found. Groups of scalenohedrons, dog tooth spar, are common, the scalenohedrons being rarely more than 1½ inches long, and in the majority of specimens they are less than 1 inch

* All of the forms described in this paper have been determined megascopically, an ordinary Bausch and Lomb lens (15x) with a focal length of about ⅝ inch being used.

in length. Many of the scalenohedrons, like the acute rhombs, have been formed by the oscillatory combination of the smaller crystals. Scalenohedrons modified by the trigonal bipyramid and scalenohedrons terminated by very small rhombs are rarer combinations that occur. Six sided prisms of calcite have been found, as at Goat Island, but this form is very rare (1). The trigonal bipyramid is another rare form in which the calcite crystallizes. Massive crystallized calcite is of very common occurrence and is found in a variety of situations.

Color.—Many of the rhombohedrons are colorless and transparent, and many others are white. Some are amber, some honey yellow, and others are yellowish white. The scalenohedrons vary from white to yellowish white, a few crystals being golden yellow or amber. The massive calcite is sometimes colorless and transparent, but is usually white or gray, rarely red.

Association.—The crystals of calcite are associated with dolomite crystals in most specimens, the two together forming strikingly beautiful drusy surfaces. Yellow and purple fluorite cubes occur with the rhombs of calcite, more rarely galena and sphalerite crystals. The surfaces of cavities may be thickly sprinkled with crystals of calcite and of other minerals which project into beautifully crystallized and transparent selenite that has completely filled the cavities. Again crystals of calcite may be completely segregated and surrounded by selenite. Cleavable anhydrite, celestite, barite, and pyrite, with a few other minerals, are more rarely found in association with calcite. The white massive cleavable calcite is generally mixed with dolomite.

Occurrence.—The crystals occur singly and in groups. The groups may be rosettes of acute rhombs or scalenohedrons, or parallel growths of scalenohedrons or acute rhombohedrons, or of both together. The rhombohedron is the crystal form commonly found on drusy surfaces, and this is the form usually found embedded in selenite, the latter making excellent cabinet specimens. Joints and other cracks wholly or partially filled with massive, cleavable or amorphous calcite are very characteristic of the limestone. Joints lined with massive cleavable calcite, the inner surfaces of which, terminating in dog tooth spar large enough to show individual crystal faces, forming comb structure, are frequently seen. Limestone fragments composing the breccia may be cemented by massive cleavable calcite, and solution cavities may be wholly or partially filled with the same material. Calcite entirely replacing fossils—*Caninia* and *Halysites* especially—and preserving the original structure, is found, and rhombs of calcite studding the interior of fossil shells are of common occurrence. Massive cleavable calcite also occurs replacing the limestone; locally considerable masses have been so replaced. Also over considerable areas the original rock has been so extensively recrystallized to coarse calcite and dolomite that it will take a polish and has been sold under the trade name of Lockport marble. The dog tooth spar is more abundant in the darker colored limestone, and rhombohedrons in the lighter colored limestone.

DOLOMITE

Importance.—Next to calcite dolomite is the commonest mineral in the Niagara limestone.

Form.—The crystal form of dolomite most often seen is the rhombohedron, generally with curved faces. Twin rhombs are not of rare occurrence, the twin being the common butterfly type, twinning on the steep negative rhombohedron $(02\bar{2}1)$; and polysynthetic twinning according to the same law—twin plane $(02\bar{2}1)$—is common giving rise to fine striations on the cleavage faces parallel to the short and long diagonals of the rhomb; also twin rhombs with twinning plane $(10\bar{1}1)$ are occasionally encountered. Acute rhombs are plentiful, and in a few specimens these rhombs are terminated with the basal pinacoid. Both obtuse and acute rhombs, with plane surfaces, are of frequent occurrence. The rhombohedrons are small, generally measuring less than 3/16ths of an inch along the edges, and as with calcite, many are so small as to be seen clearly only with a good hand lens. Many of the smaller obtuse rhombs closely resemble cubes, as in calcite. Massive dolomite occurs in quantity and in many different situations.

Color.—Many of the rhombohedrons are colorless and transparent, and many are white. Pink rhombs are also common, and specimens exhibiting a delicate pink (pearl spar) are of common occurrence. The massive dolomite is colorless to white. Reddish brown dolomite rhombs occur sparingly, and have been interpreted as both siderite and ankerite.

Association.—The mineral associates of the dolomite are the same as for calcite.

Occurrence.—Dolomite occurs as single crystals and as groups of crystals, as crystals embedded in selenite, a very common and strikingly beautiful occurrence, as vein filling and vein lining, cementing breccia, and wholly or partially filling cavities. The massive dolomite occurs in the latter situations and is usually mixed with calcite.

GYPSUM

Importance.—Gypsum occurs in abundance in the Niagara limestone.

Form.—A number of varieties of gypsum have been found, many of them making beautiful cabinet specimens. The commonest variety is selenite, which occurs beautifully crystallized, pieces a foot in length being not uncommon, however distinct crystals are rare. Complete or partially complete crystals, when found, are of the simple tabular or prismatic habit characteristic of selenite. The common crystal forms are the unit prism, clinopinacoid, and negative unit hemi-pyramid in combination, and very rarely the crystal is modified by the positive hemi-orthodome. Extremely small but perfect selenite crystals found enclosed within transparent crystals of celestite exhibited a combination of the clinopinacoid with positive hemi-orthodome, unit prism and apparently the hemi-pyramid, although it is possible the last form was the negative hemi-orthodome, the extreme minuteness of the crystals making the determination of the form uncertain. The characteristic swallow tail twin—contact, with the orthopinacoid (100) the twin plane—is rare. Fibrous gypsum or satin spar is very rare, although a few excellent specimens have been found. Compact to granular gypsum (alabaster) is very common. Loose, flaky (snowy) gypsum also occurs, and massive rock gypsum is found in quantity.

Color.—Most of the selenite is colorless and beautifully transparent. Some of the selenite is of a decided silvery color, and when admixed with slight amounts of clay, as sometimes happens, is grayish brown. The satin spar has the characteristic white color with silky lustre, and the rock gypsum is a dull gray.

Association.—The varieties of gypsum are associated with the minerals found in the solution cavities of the rock. With the gypsum, especially the selenite, are found calcite, dolomite, cleavable anhydrite, sphalerite, galena, celestite, fluorite and barite. A noteworthy association has already been described—the presence of rhombs of calcite and dolomite within the selenite. Besides these, crystals of sphalerite, galena, barite, celestite and fluorite occur in the selenite. This is the most characteristic mineral association in the Niagara limestone, and specimens illustrating this association are of great beauty. Selenite may grade into snowy gypsum, and perfect tabular crystals of selenite are found embedded in both snowy gypsum and alabaster. Silvery selenite may contain irregular patches of clay, and tiny prismatic crystals of selenite may be distributed through alabaster giving the appearance of a typical felt. Extremely small and perfect crystals of selenite were found within perfect, transparent crystals of celestite, and the latter in turn were contained within transparent selenite, indicating two generations in the crystallization of the selenite.

Occurrence.—Satin spar occurs only in solution cavities. Both the selenite and alabaster fill cavities and are common minerals binding the limestone fragments composing the breccia, especially the selenite. Veins of selenite and occasionally alabaster are found, but are not common. Selenite occurs filling cavities in fossils, and replacing fossils. Both the selenite and alabaster replace the limestone, and the rock gypsum is found replacing the limestone and in solution cavities.

FLUORITE

Importance.—Fluorite is a common mineral in the Niagara limestone.

Form.—The mineral occurs almost always in distinct crystals, which are generally perfect. The common crystal form is the cube. The cube modified by the octahedron is also relatively common, while the octahedron alone and the dodecahedron are very rarely observed in this formation. The penetration twins of fluorite, twin plane (111), are very rare also. Crystals up to 1½ inches, measured along the edges, have been found, although crystals over

.1 inch are rare. Granular fluorite is sometimes found, as well as fluorite in cleavable masses.

Color.—Many of the crystals of fluorite have an exquisite finish, with very bright splendent surfaces. Many crystals are colorless and perfectly transparent. Purple crystals are common, often a dark purple, while green and yellowish green crystals and crystals of a delicate straw yellow color are not so common. In the purple crystals the color may be evenly distributed through the crystal, or "patchy," the rest of the crystal being colorless or but slightly purple.

Association.—The mineral is associated especially with calcite, dolomite, anhydrite, sphalerite, galena, selenite and celestite. A characteristic association has already been mentioned—the presence of perfect crystals embedded in selenite.

Occurrence.—Fluorite occurs either in isolated crystals, or as clusters of crystals, especially cubes, in solution cavities or in joints, often forming beautiful drusy surfaces with other minerals.

GALENA

Importance.—Galena is a common mineral in the Niagara limestone, however it is too widely disseminated and too small in amount to be of economic importance.

Form.—The form of galena that is generally found is the cube, small and perfect. The cube modified by the octahedron, as well as the cube, octahedron and dodecahedron in combination are sometimes encountered. Other forms are very rare. Crystals up to 1 inch are found, but most crystals measure less than ½ inch. The mineral also occurs in small cleavable masses.

Color.—The color is from light to dark gray. Crystal surfaces sometimes show a beautiful purple tarnish with iridescence due to the superficial alteration (oxidation) of the mineral.

Association.—The usual mineral associates are calcite, dolomite, fluorite, sphalerite and gypsum. Perfect crystals of galena occur embedded in selenite.

Occurrence.—The mineral occurs as distinct crystals on the walls of solution cavities, also as threads and thin veins, and filling cavities. A mass weighing several hundred pounds was found at

Rochester in a single cavity, during the excavation for the old Erie canal (2). The mineral is also found apparently replacing the limestone.

SPHALERITE

Importance.—Sphalerite is a common mineral in the Niagara limestone, however, like galena, it is too widely disseminated and too small in amount to be of economic importance.

Form.—The mineral is nearly always beautifully crystallized, but perfect crystals are rare, nearly all being distorted, generally flattened with rounded angles. The dodecahedron in combination with the trigonal tristetrahedron is of very common occurrence, the crystals being rounded in most cases to produce hopper-shaped forms. The dodecahedron alone and the octahedron are other common forms. Positive and negative tetrahedrons in combination, and the tetrahedron in combination with the cube, are occasionally found, the crystals being flattened. Twin crystals—contact, with the composition face parallel to the face of the octahedron (111)—are sometimes found. All crystals are small, less than ½ inch in size in most cases. Small cleavable masses of the mineral also occur.

Color.—The mineral varies greatly in color. Transparent crystals are rather common, as well as translucent honey to wax yellow crystals. Other specimens are light to dark brown, reddish brown, and some are black. Nearly all specimens exhibit a brilliant resinous lustre.

Association.—The usual mineral associates are galena, calcite, dolomite, fluorite and gypsum. Perfect crystals occur embedded in transparent selenite, and crystals were found upon the surfaces of rhombs of dolomite.

Occurrence.—The mineral occurs as individual crystals, groups of crystals, and in small cleavable masses, partly or wholly filling solution cavities. The crystals are confined to the solution cavities. Cleavable sphalerite is found that apparently replaces the limestone, judging from megascopic examination. The mineral also serves as a binder of the limestone breccia, and sometimes completely fills the cavities in fossils. Sphalerite seems to be more abundant in the darker portions of the limestone (2).

PYRITE

Importance.—Pyrite is a common mineral in the Niagara limestone.

Form.—Crystals are common, the cube and the cube in combination with the octahedron being common forms. Pyritohedrons singly and in combination with the dodecahedron are of frequent occurrence too. Many of the crystal faces are striated. The crystals are small, less than 1 inch, in most cases less than ½ inch measured on the edges. Nodules and irregular masses are also found.

Color.—All specimens are a bright brass yellow.

Association.—The mineral occurs alone or associated with calcite, dolomite, galena, sphalerite and gypsum. A pyritohedron was found on a prism of marcasite, and several crystals were studied that were developed on the surfaces of rhombohedrons of dolomite.

Occurrence.—Distinct crystals and crystal aggregates are found lining the walls of solution cavities, while irregular masses showing crystal faces and nodular masses are found partially or wholly filling solution cavities.

BARITE

Importance.—Barite is a common mineral in the Niagara limestone.

Form.—Individual crystals of barite are rare in this formation, yet in this study a number of very small but perfect crystals were found that exhibited the following combinations: (1) Macrodome with brachydome, (2) basal pinacoid, macrodome and brachydome, (3) unit prism and basal pinacoid, (4) basal pinacoid, macrodome and prism, (5) basal pinacoid, bipyramid, macrodome and brachydome. Most occurrences of the mineral are masses composed of tabular and prismatic aggregates, the individuals being elongated parallel to the basal pinacoid and the *a* or brachyaxis. Hence nearly all individual crystals exhibit the basal pinacoid and brachydome, but the terminations are indefinite, often being buried in the limestone matrix, or broken off. Fine striations lengthwise of the crystal faces are characteristic. Crystal masses are found 2 to 6 inches in length and make beautiful cabinet specimens. Fibrous and lamellar nodules occur as well as massive barite.

Color.—The color is white to light gray and bluish gray, many of the crystals being translucent and some perfectly transparent.

The fibrous and lamellar nodules often exhibit a reddish color (1). The massive barite is snow white.

Association.—The mineral occurs alone or with fluorite, calcite, dolomite, celestite and gypsum. Perfect crystals are found embedded in selenite. Intergrowths of crystals of this mineral with crystals of celestite are also common.

Occurrence.—Barite is found partially or wholly filling solution cavities, cementing the limestone fragments composing the breccia, as vein filling, and rarely replacing the limestone.

CELESTITE

Importance.—Celestite is relatively common in the Niagara limestone.

Form.—The mineral occurs in crystals which are either prismatic or tabular due to the preponderance of the basal pinacoid. The common forms are the unit prism, brachydome, basal pinacoid and macrodome in combination. In this study the following combinations also were found: (1) Macrodome with brachydome, (2) prism, basal pinacoid and macrodome, (3) basal pinacoid, macrodome and brachydome, (4) basal pinacoid, macrodome and brachypinacoid. Most crystals are elongated in the direction of the *a* or brachyaxis, rarely in the direction of the macroaxis. The crystals may be single, but often specimens exhibit a crested divergent arrangement of a number of tabular crystals. Cleavable masses and also nodular masses of the mineral are also found, as well as fibrous aggregates. The fibers are coarse, almost friable, and may be straight, divergent, or bent in various directions and forms (1).

Color.—The crystals may be white, bluish white or blue, and are opaque to semitransparent. The fibrous variety is snow white.

Association.—The mineral occurs chiefly with calcite, dolomite, gypsum, barite, and anhydrite, or alone. Specimens often effervesce in acid due to an intimate admixture with calite. Transparent selenite sometimes contains beautiful groups of perfect crystals.

Occurrence.—The mineral is found as individual crystals, but groups of crystals are much more common, some of these groups being several inches in length. The mineral is also found in solution cavities and binding limestone fragments composing the breccia.

ANHYDRITE

Importance.—Anhydrite is a relatively common mineral in the Niagara limestone.

Form.—The mineral may occur as massive fragments or in crystallized and cleavable masses. The cleavage is the typical orthorhombic, pinacoidal (pseudo-cubic) type characteristic of anhydrite. Foliated masses also are found (1).

Color.—The specimens range from dark gray to blue, and are transparent to translucent. The non-cleavable massive anhydrite is dull gray and opaque.

Association.—The mineral is associated especially with calcite, barite, celestite, dolomite, and gypsum, and may show alteration to gypsum locally. It is often mixed with calcite, so that fragments effervesce on contact with acid.

Occurrence.—It occurs in solution cavities, as replacement of the limestone, and as a binder of the limestone fragments composing the breccia.

STRONTIANITE

Importance.—In comparison with the minerals already discussed strontianite is a relatively rare mineral in the Niagara limestone.

Form.—It occurs in small and imperfect crystals rudely spear-shaped or acicular, also in radial aggregates. Crystalline masses of the mineral have also been found.

Color.—The specimens are white and translucent to opaque.

Association.—The mineral is associated with celestite, galena, calcite, dolomite, barite, and gypsum.

Occurrence.—It is found lining joint surfaces and in solution cavities.

ARAGONITE

Importance.—Aragonite is a relatively rare mineral in the Niagara limestone.

Form.—It is found in small aggregates of prismatic crystals, and at Lockport as *flos ferri* coating gypsum (1).

Color.—The specimens are colorless and transparent to the snow white characteristic of *flos ferri.*

Association.—The mineral is associated chiefly with calcite, dolomite and gypsum.

Occurrence.—Aragonite is restricted in its occurrence to solution cavities in the limestone.

MARCASITE

Importance.—Marcasite is a relatively rare mineral in the Niagara limestone.

Form.—It occurs in small granular aggregates and as minute crystals only a small fraction of an inch in size. The crystals are tabular and wedge shape, or short to long columnar. Extremely small striated columns occur that appear to be perfectly terminated, however the terminal faces are too small to be deciphered megascopically. On some of the larger crystals the following combinations were determined with certainty: (1) Prism with brachydome, the brachydome being greatly elongated, (2) prism and basal pinacoid with brachydome.

Color.—The color of the crystals is the characteristic pale bronze yellow.

Association.—The mineral associates are in most places pyrite, galena and sphalerite. The extremely small columnar crystals discussed above were found upon the surfaces of rhombs of dolomite.

Occurrence.—The mineral is found lining the surfaces of cavities and occasionally on the exposed surfaces of the limestone.

Minerals of Minor Importance

SULPHUR

Sulphur is a rare mineral in the Niagara limestone, but, when found, it is almost always beautifully crystallized. Many of the crystals are perfect acute bipyramids which are associated with bipyramids that are distorted, in most cases flattened. On some of the crystals bisphenoid faces may be recognized, and some of the very tabular crystals owe their shape to the preponderance of the basal pinacoid. The crystals are confined to the solution cavities in the rock, and are sulphur yellow to straw yellow in color, and translucent to almost transparent. They are associated with calcite, dolomite, sphalerite and fluorite. An interesting association discovered was the intergrowth of long tabular crystals of the sulphur with the prismatic crystals of barite. The mineral also occurs as incrustations or coatings on the surfaces of solution cavities, joint surfaces, and on exposed surfaces of the limestone. Flakes and small grains of sulphur occur in similar situations, and under the lens are seen to be imperfect crystals, however they are so small that the determination of the crystal forms is impracticable with the hand lens.

SIDERITE

Siderite is a rare mineral in this formation, however cleavable masses and rhombs of the mineral are occasionally found. It is probable that much of this material is ferruginous dolomite, and possibly some of it may prove to be ankerite. The mineral is restricted to solution cavities in its occurrence.

QUARTZ

Quartz is a rare mineral in the Niagara limestone, if the amorphous cherty nodules found in solution cavities are excepted. Only one example of crystallized quartz was found in the large collection studied by the writer. The surface of this specimen was composed of innumerable and extremely minute quartz crystals, resting on a base of crystallized dolomite, and apparently representing the inner lining of a geode. The crystals were transparent, perfect and simple, the only forms found being the hexagonal prism terminated by the hexagonal bipyramid.

MAGNESITE

Small white cleavable masses of this mineral are sometimes found, however the mineral is very rare.

RUTILE

Rutile is sometimes found in solution cavities as long delicate prismatic crystals of dark brown color which appear like black hairs that are either attached to or penetrate calcite and dolomite crystals. The crystals are striated longitudinally, and possess a high vitreous, almost metallic lustre, with surfaces tarnished in some specimens. The mineral is fusible to a black globule which is attracted by the magnet. This property has led some observers to identify the mineral as acmite, rather than rutile. The mineral also occurs in the efflorescence on the exposed surfaces of the limestone.

CHALCOPYRITE

Chalcopyrite has been reported from the Niagara region where it occurs in cavities in the limestone associated with malachite (4).

MALACHITE

Small masses of this mineral occur in the solution cavities in the limestone in the Niagara region (4), and elsewhere. The mineral is also found as a green stain coating the surfaces of the limestone in joints and cavities. Like chalcopyrite it is a rare mineral in the Niagara formation.

Mineral Associations

The mineral associations have been discussed in the case of each mineral of importance in the Niagara limestone. There remain only certain generalizations and conclusions to be emphasized. Calcite and dolomite occur together nearly always; the same is true of galena and sphalerite, celestite and barite, pyrite and marcasite, and gypsum and anhydrite. Again an intimate association of all or most of the important minerals found in the Niagara formation will be revealed in a single small cavity. Apparently there is no law governing this association, which makes collecting the more fascinating for each find illustrates different combinations of minerals. The presence of crystals of various minerals within transparent selenite has been repeatedly mentioned. It is possible to explain this intimate association in two ways: (1) The minerals embedded in the selenite crystallized upon the limestone walls of solution cavities and later these walls were replaced by selenite, the solutions finally entirely filling the cavities, leaving the crystals within the selenite mass. (2) The solutions precipitated the selenite on the rock walls around the bases of the crystals and the latter were wedged off by the force of crystallization of the growing selenite masses to be completely surrounded by selenite with the final filling of the cavities.

Origin of the Minerals

The minerals of the Niagara limestone have arisen for the most part by precipitation from percolating ground water long after the formations were elevated above the sea and consolidated. In most cases their origin postdates the formation of the solution cavities characteristic of the limestone, hence they are relatively recent geologically. None was deposited by magmatic waters. A few individual specimens, possibly some of the fluorite, were deposited from connate waters. Some of the anhydrite has been altered to gypsum. The sulphur may represent the oxidation of hydrogen sulphide either introduced from above by underground water that has circulated through decaying organic matter near the surface, or formed in the oxidation of the sulphides galena and sphalerite, minerals found in association with the sulphur. The sulphur may also have originated in part by the reduction of such sulphates as celestite, barite, gypsum and anhydrite, the reducing agent being the bituminous matter in the limestone, soluble and easily decomposed sulphides being formed which readily yielded hydrogen sulphide that has oxidized to form sulphur. The malachite represents in part at least the carbonation and hydration of chalcopyrite.

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THE FUNGI OF OUR COMMON NUTS AND PITS.

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Lyndonville, N. Y.

The mycologic flora of nuts and pits is somewhat extensive. Consequently this article is limited to a consideration of the species of fungi found on some common varieties. The species enumerated here have mostly been found in Western New York although some extralimital ones are described for the reason that they throw light upon the forms already found, or may reasonably be expected to be collected here in the future. Both saprophytic and parasitic fungi are included in this summary. Other forms of cryptogamic vegetation besides fungi thrive upon nuts. Hickory nuts are often overrun by mosses and the writer has observed upon the involucral prickles of beechnuts an alga of the genus *Oscillaria.*

The commercial value of some of the hosts is well known. Nuts are everywhere on sale either in shells or in the salted or unsalted shelled condition. In late years their use has steadily advanced as ingredients in the manufacture of ice creams, candies, pastes, jams, relishes, breads, cakes and cookies. Anything which diminishes the supply or causes deterioration in appearance or flavor has an economic importance and fungi are responsible for just those things. Serious losses from nut diseases have been inflicted upon growers. Thus, according to Crittenden (1) one Thomasville, Ga., grower sold his crop of Schley pecans which were damaged by kernel spot for 25 cents per pound when prices for good Schleys ranged from 50 to 60 cents. Spooner (2) says he has observed one season in which practically every nut in one grove was destroyed by scab before the season was half over. There is a great difference in the susceptibility of varieties to the attacks of these fungous enemies. There are also seasonal differences, for wet seasons promote the rapid growth of fungi, and yet the observer mentioned above found even in dry seasons that great fungous injury was shown by the presence of many undersized nuts.

Nuts exposed for sale have been under suspicion of spreading diseases of nut trees. J. Franklin Collins (18) found fresh chestnuts infected with *Endothia parasitica* and says it would be possible "to introduce the disease into a new locality by means of the discarded shells or kernels of the diseased nuts." This view is also supported by Miss Rumbold (17).

Saprophytic molds such as *Penicillium* and *Aspergillus*, or related hyphomycetous forms, growing upon various nut meats certainly injure the appearance and no doubt cause bitter, moldy and disagreeable flavors. For a more extended consideration of this deterioration of taste and flavor of nut meats we may well await the publication of the researches of Prof. Charles Thom, mycologist of the microbiological laboratory of the U. S. Department of Agriculture, who has collected material upon this subject in connection with the miscellaneous examination of food stuffs which come through this laboratory. In fact the condition of nuts called "bitternut" usually results from the spread of fungus mycelium through the kernels. Miss Rumbold (17) reports that nuts infected with the chestnut blight fungus are extremely bitter to the taste. From a hygienic standpoint it is best to avoid eating nuts which have a bitter taste, or are evidently moldy or subject to bacterial decomposition. Even the operation of cooking does not remove the danger of food poisoning. Pecan nuts, according to Talbot (3) have caused asthma in children and a drug manufacturing concern has put out Arlco proteins of pecan and Brazil nuts for testing the sensitiveness of patients to these anaphylactic disturbances. At first thought it might seem that fungous decay in the nuts would be responsible for these maladies, but R. P. Wodehouse, of the firm above mentioned, in answer to an inquiry by the writer reports that "nowhere do we recall ever having seen reported a case of anaphylaxis due to the products of fungi degeneration of nuts. In fact, anaphylaxis practically always is due to the native protein and the activity in this respect tends to be destroyed, rather than enhanced, by any kind of degeneration." It becomes necessary to distinguish between poisoning from sitotoxicons from nuts with fungus infection and personal idiosyncrasy or even simple gastric disturbances in any given case of supposed illness from nut eating.

As regards changes in appearance due to fungi first should be noted alterations in size so that the nuts do not grow to standard dimensions. Premature spotting and dropping of walnuts is caused by infection with Bacterium Juglandis. Whether hickory or other nuts are subject to bacterial disease has apparently not been investigated. Nut meats are variously discolored by the growth of fungi. The shells and shucks are also much injured in color from the same cause. This discoloration may involve the whole surface of the shell or shuck or, on the other hand, occur in limited areas. Sometimes fungi are found exclusively on whitened spots. The following colors are found on affected nuts and shucks: green, black, brown, purple, crimson, red, pink, yellow or white. The various stains are, as a rule, due to the growth of special fungi. Thus a uniformly blackened surface may be due to the growth of species of *Fusicladium* or *Helminthosporium*. Purple spots are often due to *Epicoccum*. Special care should be taken by observers and collectors not to mistake accidental discolorations for those due to fungi. For instance hickory nuts are at times accidentally stained by the juice of elderberries and the resulting purple stains almost exactly resemble those produced by the growth of *Epicoccum purpurascens*. The discoloration of hickory nuts may extend clear through the shell even to the nut interior and we have traced mycelial growth almost through the nut tissues. In some instances the growth of mycelial threads upon nuts is so prolific and densely aggregated that it has received the name of "Black Crust." E. R. Spencer describes a fungus disease of Brazil nuts (4) in which the kernel is covered by a black mycelium which destroys the outer cell layers. Spencer attributes this to a fungus which has globose, hairy pycnidia, with spores 2-celled, black, conspicuously striated, measuring 21 x 13 μ and which in a personal communication he says "belongs to the Diplodia group. I am calling it *Pellionella macrospora* as it has much larger spores than any species of the genus." Black Nut of hickory nuts may be either external or internal, local or general, and may occur on hard nuts as well as those softened by decay or other causes. Sometimes it appears to be due to atmospheric or degenerative changes, and at other times to a growth of *Helminthosporium*, to the clustered pycnidia of deuteromycetes, or, as in the form called by Berkeley and Curtis *Hypoxylon nucitena*, to the subcoalescent growth of the perithecia of pyrenomycetes. Yellow Nut of hickory nuts is also often encountered. In this disease the nuts are usually undersized, yellow in color, and with thin external walls. The inner partition walls are also much thinned and often reduced to mere papery plates. The nuts are easily crushed between the fingers. The yellow discoloration usually extends through all the nut tissues. The kernel is atrophied or absent. The cause of this disease has not been definitely ascertained. In many cases no recognizable fungus or insect depredation was found by the author on affected nuts. It probably is a disease of mixed causation, sometimes due to nutritional or developmental defects, or the so-called physiologic disease, which is but a convenient pigeonhole for ignorance, and sometimes due to the growth of fungi. In the yellowing of the kernels of horse-chestnuts the cause is clearly due to the growth of fungi of the *Penicillium* group, and in these same kernels we often find a mixed infection with other spots of yellow intermingled with white, black, or purple areas caused by the simultaneous development of other fungus species. Pecans are often discolored by the growth of *Fusicladium effusum* upon the outer surface of the shells and this disease is called Pecan Scab. Rand (5) states that pecan kernels are attacked by *Coniothyrium caryogenum* Rand which causes "dark brown, irregularly rounded surface spots with a hemisphere of pithy tissue beneath which is surrounded by a brownish layer of host cells." This disease has the name "Kernel Spot of Pecans." Bitterness of the kernel results. Even so acute an observer as Schweinitz in his description of *Dothidea Missouriensis* Schw. on pecans mistook the sterile crust for the fungus itself. His own words from Syn. Amer. bor. n. 1886 are "efformans maculas effigurates, e fusco nigronitentes plerumque longitudinaliter productas, interdum tamen latius effusas, confluentes, etc."

The growth of the mycelium of *Endothia parasitica* (Murr.) A. & A. in chestnut kernels causes a progressive change in color from a shining, bright yellow to dull light gray. Soft or crumbly nuts. This disease or condition is brought about by fungus infection and is especially observable in chestnuts.

It has excited the wonderment of several people, not trained mycologists, upon seeing a collection of nut fungi that so many different species could be found thereon, and have expressed amazement that anything at all would grow upon such an apparently unfavorable habitat. For the benefit of those unfamiliar with the subject it may be briefly stated that cryptogams often live on many matrices where nothing would be expected to grow. We are all familiar with lichens growing upon rocks. In regard to mosses Mrs. E. G. Britton (6) says: "Mosses sometimes grow in very strange places. Once I found *Ceratodon purpureus* in a shell near the sea coast, and some of the *Splanchnaceae* will only grow upon bones or excrement of animals. Some of the oil of the nut with a little accumulated soil may have been sufficient to nourish a moss on the hickory nut, or it may have crept over it from the ground where it was growing." Prof. Roland Thaxter has found a large number of new *Laboulbeniaceae* growing on the hard chitinous parts of insects and in the case of the ascomycete *Cantharosphaeria chilensis* tells us (7) that "it is not unlikely that it may obtain its necessary materials from the film of foreign matter which covers the surface of the host." The species of nut fungi may not all be truly nucigenous, that is deriving their nourishment entirely from the nut, but may, in some instances, find suitable trophic conditions in accumulated débris on the nut surface. We may expect to find almost any of the common saprophytic fungi growing upon nuts and pits and the only reason more have not been listed is because these hosts have not been as closely observed as other hosts of more frequent occurrence, greater economic importance or easier determination. M. C. Cooke (8) tells us that "fungi should make their appearance and flourish in localities generally considered inimical to vegetable life is no less strange than true." "It may well occasion some surprise that fungi should be found growing within cavities wholly excluded from the external air, as in the hollow of filberts and the harder shelled nuts of Guilandina, etc." Miss Rumbold (17) has found inside the hard shell of the chestnut uncontaminated growths of the blight fungus and molds "especially *Penicillium* sp. had in some cases penetrated the kernel." Here the infection came through the burs and entered the nut at the base where there is a close connection between the nut and bur and where the outer shell remains soft until near the maturity of the fruit.

In regard to the place of elective growth of fungi on nuts and pits we may say that fungi may be found at any place on the shell, or in the interior of the hosts. They are frequently found at the acute tips of hickory nuts and nowhere else on the nut. This may be, at least in many instances, accounted for from the fact that the outer shuck often is dehiscent only at the tip and when the apex of the nut is exposed in the resulting cleft fungi very readily find access and grow in a very favorable situation. Schweinitz observed this seat of fungus growth for he says of one of his species that it is found "praesertim in cacumine nucis." The comparatively smooth surface of hickory nuts and cherry stones seems a more favorable location for fungi than the rough and furrowed exterior of walnuts and peach pits. Nevertheless fungi do grow upon the latter matrices and it is not a rare occurrence to find *Caryospora putaminum* (Schw.) De Notaris growing on the external surface of peach pits, sometimes on the ridges, sometimes in the valleys or depressions between the ribs.

The relation of the histological structure of hickory nuts to the growth of fungi has not been extensively investigated. Simple inspection with a hand lens reveals three layers: first an external, thin, epidermal and protective layer often removable by the simple process of peeling; second, a middle layer, which is thickest, and third, an inner coat. Pycnidia and perithecia are often found sunk in the outer layer, extending as far as the middle layer. After removal of the fruit bodies for examination a depression is often seen evidently reaching as far as the middle coat. Microscopic details of the changes in structure in nut tissue from the growth of fungi have not been satisfactorily studied.

Insects have been suspected to cause fungus disease of nuts by carrying in the spores on their bodies. According to investigations conducted by the Georgia State Board of Entomology in 1917 the green soldier bug, *Nezera hilaris,* is a very important factor in the production of Spot disease. Turner (9) states that "we have not been able to determine absolutely whether the spot is caused by a fungus which is carried by the bug, or whether the spot is directly due to the feeding of the bug." Dr. E. P. Felt (10) states that "it would not surprise me if *Nezera hilaris* caused the Kernel Spot in pecans since I know of a related species which pierces the pods of peas and produces a shrunken affected area in the developing peas. The same species causes a somewhat similar injury to green corn and tomatoes and I would therefore think it quite possible that a bug might be responsible for the Kernel Spot."

In Western New York the mite *Oribella pilosa* Banks is found living between the shuck and nut of black walnuts and hickory nuts are frequently eaten by some insect which is probably the larva of the pecan shuckworm *Laspeyresia caryana* Fitch. The role they play in fungus development is unknown. In fact we are forced to agree with the observations of Felt, loc. cit. "an invasion by any such insect would naturally be followed by entry of smaller insects, moisture and the development of various molds and fungi. It would require a considerable series of specimens taken at various stages of development to determine the species concerned and the part each might play in the introduction of vegetable organisms." For the insects harbored by our nut trees consult the monograph by Dr. Felt. (11)

It has been a custom of mycologists to separate the genera of pyrenomycetes and some imperfecti according to their manner of growth, that is whether superficial or immersed in the tissues of the host. These differential characters do not hold good in the determination of nut fungi. Thus in a specimen of *Sphaeropsis* on hickory nuts from Upper Alton, Illinois, the pycnidia on the shuck were found to be typically subepidermal while those growing on the nut shell in lines between the dehiscence of the shuck were absolutely superficial. The same thing has been observed on nuts without shucks. Ellis and Everhart (12) have observed similar growth in the case of *Didymella fructigena* E. & E. which when it occurs on dried up cherries has the perithecia covered, but "when growing on the denuded cherry stones superficial with the base adnate." From which it follows that species of *Phoma* happening to grow on the sclerenchyma of nuts and pits are apt to be put in *Aposphaeria, Didymella* called *Melanopsamma,* while species of *Leptosphaeria* would be referred to the genus *Melanomma,* if we adhere strictly to superficial growth as a diagnostic feature. Where it is possible to have other data, such as details of the structure of stroma, perithecia, asci and spores, these should be given equal, perhaps greater weight in determining the genus of the species under examination.

In the study of nut and pit fungi each nut or pit must be separately examined by the microscope and samples taken from different locations on the same specimen for it would be misleading to consider the fungi as all the same in any given collection simply because they were apparently similar under a hand lens or low power binocular. The author's specimens have thus been gone over, nut by nut, and it has taken the leisure of almost a year and a half to examine the collection and report the results here recorded.

It redounds to the credit of American Mycology that much of the work on our nut fungi has been accomplished by native scientists. Schweinitz, the pioneer investigator of the fungi of this country, described forms which are good and noteworthy species, such as *Sphaeria putaminum, Sphaeria pericarpii, Sphaeria caryophaga* and *Arcyria globosa*. Later, Charles H. Peck, N. Y. State Botanist, added *Phoma exocarpina* and *Caryospora minor* to the list. J. B. Ellis, of Newfield, New Jersey, perhaps the greatest of American pyrenomycetologists, has given us descriptions of *Hendersonia pustulata, Aposphaeria nucicola, Pestalozzia nucicola, Teichospora nucis, Glonium caryigenum, Melanopsamma abscondita, Didymella fructigena,* and other less remarkable forms. A few scattered species are to be placed to the credit of other individuals, but to the three above mentioned belongs the honor of laying the foundation of nut and pit pathology in this country. This article, which is not to be considered a monograph, does not attempt any serious revision of genera and species, and the names in common use are generally selected.

In the following list several groups of fungi are unrepresented. No members of the *Ustilagineae* or *Uredineae* have been found by the author on nuts and pits. Among the *Basidiomyceteae* there has been twice collected on hickory nuts at Lyndonville, N. Y. a depauperate *Coprinus* which refuses to yield spores and is therefore at present not in condition for identification. In the *Gasteromyceteae* we have only to record the common bird's nest fungus *Crucibulum vulgare* found growing on oak acorns on the banks of Oak Orchard Creek near Point Breeze in Orleans County, N. Y.

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Note.—In corroboration of the view expressed in the text regarding the possible toxicity of nuts infected with *Penicillium* sp. the results of the experiments of Sturli (16) seem to prove the toxic action of mycelium and spores. Rabbits fed upon mycelium of Penicillium glaucum, grown upon Raulin's medium, or injected with alcoholic extract of the mycelium, developed convulsions, cramps and death.

List of Species.

FUNGI IMPERFECTI.

SPHAERIODACEAE.

1. **Phomopsis carposchiza** sp. nov. Pycnidia at first immersed becoming pustuliform elevated and finally suberumpent, splitting the epidermis in a laciniate manner, surrounded by an elevated border, often lying singly or in groups at the bottom of depressions between the laciniae, black, sometimes shining at the apex; spores fusoid, 2-guttulate, hyaline, 6–8 x 1.5–2 μ; sporophores long filiform, hamate, hyaline, 17–24μ in length. On the exterior surface of horsechestnuts, Lyndonville, N. Y., C. E. Fairman. This form has been observed for many years at the above mentioned locality. It comes near to *Phomopsis carpogena* (Sacc. and Roum.) Diedicke from which it differs in gross appearance and manner of erupting, and probably has a connection with a different *Diaporthe*.

2. **Phoma exocarpina** Peck, 46th Rep. p. 38. On pericarp of *Carya porcina,* Michigan, G. H. Hicks. What appears to be the same thing was found at Lyndonville on the inner surface of nut shuck of some species of *Hicoria,* May 1, 1919, C. E. Fairman, with spores 6–10 x 3–3.33 μ borne on long slender sporophores. Also on nuts of *Hicoria,* Albion, N. Y. May, 1919, Miss Lucy Porter, Dr. L. B. Wright and Miss Clara Gray. On nut of *Hicoria,* South Hill, Ithaca, N. Y., Aug., 1918, George Hume Smith. Plate 15, fig. 6.

3. **Macrophoma Fitzpatriciana** sp. nov. Pycnidia gregarious or scattered, immersed becoming erumpent-superficial, globose, black, 400–500 μ in diameter: spores numerous, fusoid, attenuated at the ends, straight or curved, hyaline, 14–20 x 3–4 μ, apparently borne on filiform, fasciculate sporophores. On hickory nuts, Forest Home, Ithaca, N. Y., Harry M. Fitzpatrick. Distinguished readily from *Rhabdospora baculum* by its fusoid spores and immersed pycnidia. Plate 15, fig. 4.

4. **Aposphaeria allantella** Sacc. and Roum. Reliq. Lib. Ser. IV., n. 83. Sacc. Sylloge, III., 171. Our specimens have the following characteristics: pycnidia scattered or gregarious, superficial, globose, black, 150–250 μ in diameter; spores allantoid, straight or curved, hyaline. In the original description the sporophores are said to be inconspicuous, but the specimens herein listed often afford long, filiform basidia. On hickory nuts, Lyndonville, N. Y., May, 1919, Fairman, Wright & Gray. Plate 15, fig. 2.

5. **Aposphaeria nucicola** Ell. et Everh. Bull. Torr. Bot. Cl. 1897, p. 287. Sacc. Sylloge Fungorum, 14:894. On hickory nuts, Newfield, N. J., Ellis and Lyndonville, N. Y., Fairman. Also on cherry pits, Lyndonville, N. Y., July, 1920, Fairman. Plate 15, fig. 1, drawn from original specimen in Ellis Collection.

6. **Rhabdospora baculum** Grove, Kew Bull. Misc. Inf. No. 4, 1919, p. 195. Syn. *Phoma baculum* Sacc.; *Sphaeropsis baculum* Ger.; *Macrophoma baculum* Berl. & Vogl. Pycnidia scattered or gregarious, globose or globose-depressed, 250–500 μ in diam., black; spores oblong cylindric, rounded at the ends, granular, or occasionally minutely guttulate, hyaline, usually measuring 13–17.5 x 2.5–4 μ, frequently reaching 27 μ in length; sporophores short, hyaline often inconspicuous or absent.

On outer surface of hickory nuts, and sometimes on the inner partition walls of cracked nuts, Lyndonville, N. Y., and Ridgeway, N. Y., May, 1919, Fairman. On acorns of some species of *Quercus*, Banks of the Oak Orchard Creek, near Point Breeze, Orleans County, N. Y., Aug. 1, 1920, Miss Clara Gray. On old pericarp of horsechestnut, Lyndonville, N. Y., Aug. 1920, C. E. Fairman. The last has spores 17 x 2.5 μ. Plate 15, fig. 3.

7. **Rhabdospora baculum nucimaculans** var. nov. Pycnidia scattered or gregarious, immersed becoming superficial, with a more or less adnate base, globose, obtusely ostiolate, dull black, shining at the apex, 100–200 μ in diam.; spores numerous, oblong or cylindric, rounded at the ends, simple and continuous, hyaline, 6.66–11 x 1.5–2.5 μ, borne on long slender sporophores which, however, are often absent. On hickory nuts, Lyndonville, N. Y., May, 1919 and 1920, Fairman. On cherry-pits, Lyndonville, N. Y., May, 1919 and 1920, Fairman. The cherry-pit specimens measure 5–11 x 2–3 p. The plant is smaller throughout, but since the spores are precisely the same in form we are calling it merely a small spored variety. Plate 15, fig. 5.

8. **Vermicularia Dematium** (Pers.) Fr. Pycnidia scattered, immersed, then becoming erumpent, globose-depressed, crowned with bristles, black, minute; pycnidial bristles acute at tips, bulbous and connected at the base, brown, 70–165 x 6–7 μ; spores fusoid, crescentic, rarely straight, often multiguttulate, hyaline, 17–24 x 3.5–4 μ. The above description applies to a quite common *Vermicularia* on nuts and pits which we can not distinguish from what is common on herbaceous stems and goes by the name *V Dematium.* On hickory nuts, Waterport, N. Y., Dr. R. W. Bamber, June 1, 1919. On hickory nuts, Lyndonville, N. Y., Fairman. What appears to be the same thing was collected on hickory nuts at Orient, Long Island, N. Y., by Roy Latham in 1919. Mr. Latham's specimens have setae 120–250 μ in heigth, and fusoid, curved spores measuring 20–27 x 2.5–3 μ. In all the specimens examined a tuft of long, rigid setae is all that can be seen projecting above the surface of the nut. Plate 15, fig. 10.

9. **Vermicularia exocarpinella** sp. nov. Pycnidia gregarious, immersed then erumpent, globose or globose-depressed, surrounded by brown or black, simple, non-septate, acute tipped bristles

of great variability in length, ranging from 50–250 μ x 4–7 μ black, 150 μ and upward in diam.; spores straight, incurved at the tips, hyaline or greenish hyaline, fusoid, endochrome often pseudoseptate at the middle of the spore, 20–23 x 3–4 μ.

On shucks of hickory nuts, Letchworth Park, N. Y., July 11, 1920. Miss Clara A. Gray.

10. **Vermicularia putaminicrustans** sp. nov. Pit-incrusting *Vermicularia*. Pycnidia numerous, gregarious, forming or imbedded in a black, felted crust, globose, surrounded by straight, rigid, black bristles, 60–200 μ in length and 4–6 μ in breadth, bulbous dilated at base, tapering gradually upward to a subacute tip, black, 125–150 μ in diam.; spores fusoid, subcrescentic, 24–30 x 3.5–4 μ, hyaline. On cherry pits on the ground under cherry trees, Oak Orchard on the Ridge, Orleans County, N. Y., and Lyndonville, N. Y., July 1920, C. E. Fairman.

Easily recognized from the black crust which covers the pits.

11. **Pyrenochaeta nucinata** sp. nov. Pycnidia cespitose, occasionally subcoalescent, at times scattered, erumpent-superficial, globose, centrally ostiolate, surrounded by bristles, black, 175–300 μ in diam.; pycnidial bristles numerous, straight or curved, rigid, subobtuse at the tips, not usually septate, 40–150 μ in height and 6–7 μ broad at the base; sporophores numerous, somewhat stout, simple or branched, 17–50 x 1.5 μ; spores many, oblong or cylindric, rounded at the ends, simple, continuous, hyaline, about 10–12 x 1.5 μ. Plate 15, fig. 7a and 7b.

On a hickory nut, Lyndonville, N. Y., Oct. 13, 1919, Miss Clara Gray.

12. **Dothiorella nucis** sp. nov. Stromata scattered or gregarious, immersed becoming erumpent-superficial, rounded, oblong or irregularly confluent, more or less elevated, with irregular ridges and depressions here and there, with one to four or more shining black ostiola, black, 250–1250 μ in diam.; loculi one to several, globose, angular, or of variable form, the intervening walls generally broken down, causing a series of communicating chambers or an open, central, cavity, lined with a light colored or greenish hyaline to sordid layer of simple or branching, moderately long, filiform sporophores; spores oblong cylindric, continuous, granular or with 1-2 small guttulae, hyaline, 13.3–17 x 3.3 μ, borne on the

sporophoric layer. On the outer blackened surface of hickory nuts, Lyndonville, N. Y., May, 1919, C. E. Fairman. Plate 15, fig. 9. Quite different from *Dothiorella Hicoriae* Dearness and House which has spores 15–18 x 10–12 μ.

13. **Sphaeropsis pericarpii** (Schw.) E. & E. Syn. *Sphaeria pericarpii* Schw., N. Am. 1590; *Sphaeropsis pericarpii* Peck, 25th Rep. p. 85; *Sphaeropsis Caryae* C. & E., Grev. V, p. 52; *Sphaeria involucri* Schw., in Herb. Schweinitz; *Sphaeropsis pericarpii* (Schw.) E. & E., Proc. Acad. Nat. Sc. Phil. 1895. On hickory nuts, Bethlehem, Pa., Schweinitz; N. Y. State, Peck; New Jersey, Ellis; Upper Alton, Illinois, Miss Alice Fairman; Lyndonville, N. Y., Charles E. Fairman. The spores will average 20–25 x 10–12 μ. Plate 15, fig. 8.

14. **Sphaeropsis pallidula** sp. nov. Pycnidia scattered, gregarious or coalescent, globose or ovate-globose, subsuperficial, base adnate and slightly sunk in the matrix, with minute, slightly protruding ostiola, perforate at times, pale brown, lighter toward the apex, about 200 to 250 μ in diam.; sporophores stout, long branching, hyaline: spores ellipsoid, sigmoid or inequilateral, pale brown to reddish brown, hyaline at the ends, 14–27 x 6–7 μ.

On a hickory nut, Lyndonville, N. Y., May 3, 1919, C. E. Fairman. This appears to be a connecting form between the *Sphaeropsideae* and *Zythiaceae*. The light color, soft, waxy structure, and poorly developed pycnidial cells suggest the latter. Plate 16, fig. 6.

15. **Coniothyrium caryogenum** Rand, Journal of Agricultural Research, Vol. I, p. 334, 1914. Pycnidia roundish, ostiolate, thin walled, dark brown, about 200 to 250 μ in diameter; sporophores short or not distinct; spores pale brownish, ellipsoid, 1-celled, 2.5–3.6 by 1.8 to 2 μ. On kernels of *Carya illinoiensis* (Wang.) K. Koch from the pecan belt in Georgia, North Carolina, Florida, Louisiana and Texas.

16. **Haplosporella Aesculi** (Faut. & Roum.) comb. nov. Syn. *Sphaeropsis Aesculi* Faut. & Roum. Rev. Mycol. 1892, p. 113 and Saccardo, Syll. Fung. XI, p. 512. Pycnidia single or plurilocular, at first immersed then becoming erumpent, surrounded by laciniate fragments of the pericarp, black, variable in dimensions; spores rounded or ellipsoid, at first hyaline, then brown, continu-

ous, often granular or guttulate, 15–30 x 10–14 μ, borne on stout, thick, hyaline basidia. Frequently found on old pericarps of horse-chestnut, Lyndonville, N. Y., C. E. Fairman. The spores exceed the dimensions of *Sphaeropsis pericarpii* (Schw.) and seem indistinguishable from the *S. Aesculi* found by Fautrey and Roumeguere on the bark of *Aesculus*.

17. **Diplodina epicarya** sp. nov. Pycnidia mostly gregarious and clustered, rarely scattered, immersed, becoming erumpent superficial, globose, opening by a central pore, often collapsing with age, dull black, 200–300 μ in diameter; spores numerous, ellipsoid, obtusely rounded at the ends, continuous at first becoming 1-septate, not constricted at the septum, hyaline or subhyaline, 6–10 x 2–3 μ, borne on long hyaline sporophores, about 20–23 μ in length. Plate 15, fig. 11. On hickory nuts, Lyndonville, N. Y., Apr. and May, 1919, C. E. Fairman, and Oct. by Miss Clara Gray. On nuts of Black Walnut, Lyndonville, N. Y., 1919, Fairman. The pycnidia are Phoma-like in structure, and we have followed Diedicke in Ann. Mycol. 10: 143 in the generic reference.

18. **Stagonospora nuciseda** sp. nov. Pycnidia gregarious or scattered, immersed at first finally becoming erumpent through the slightly raised and lacerated epidermal layer of the nuts, or subsuperficial, globose or ovate-globose, centrally ostiolate, black, 130–250 μ in diam.; spores numerous, oblong cylindric, subattenuate and rounded at the ends, 1–3-septate, slightly or not at all constricted at the septa, hyaline to subhyaline, yellowish when massed, 17–20 x 3–4 p; basidia inconspicuous. On hickory nuts lying on the ground, Lyndonville, N. Y., Apr. 1919. On the smooth, flat, inner surface of a Black walnut, Lyndonville, N. Y., May, 1919. C. E. Fairman. Plate 15, fig. 12. Rarely the spores are acute at the ends.

19. **Stagonospora nucicidia** sp. nov. Pycnidia scattered, globose, erumpent-superficial, black, minute; spores straight cylindric, obtuse at the ends, 4-locular, end cells conoid, middle cells short cylindric, external cell wall colorless or inconspicuous, 3-septate, not constricted at the septa, hyaline, 17–20 x 3–3.5 μ. Plate 17, fig. 12. On hickory nut, Lyndonville, N. Y., 1919, C. E. Fairman.

20. **Hendersonia pustulata** E. & E. New Fungi in Proc.

Acad. Nat. Science, Phil. 1893. On old hickory nuts lying on the ground, Newfield, N. J., Ellis, May 17, 1893. On hickory nuts on the ground, Lyndonville, N. Y., Apr. and May, 1919, C. E. Fairman. Plate 16, fig. 1. The specimen in the Ellis collection at the New York Botanical Garden is on the inner partition walls of half a hickory nut (sometimes on the inner surface of the shell), and occurs singly or clustered, raising the epidermis in a pustuliform manner, the pustules being flattened and cracked on the top. The author found abundant specimens at Lyndonville, on the exterior surface of the nuts and there is an absence of the pustules noted by Ellis. Hence the specific name *pustulata* is misleading.

21. **Diplodia** sp. Pycnidia scattered or gregarious, erumpent-superficial, black, about 200 p in diameter; spores ellipsoid, hyaline and continuous at first, becoming brown and uniseptate, constricted at the septum only now and then, 17–24 x 10–14 μ. On hickory nuts and shucks, Lyndonville, N. Y. and Ridgeway, N. Y. May, 1919, C. E. Fairman. On hickory nuts Albion, N. Y., 1919. Miss Lucy Porter. Specimens of *Sphaeropsis pericarpii* (Schw.) often afford a few spores which have become uniseptate. In the specimens above listed the 1-septate spores are more numerous than usual and we are calling them *Diplodia,* but whether related to any of the Diplodias described on hickory trees cannot, in the absence of cultures and inoculations, be stated. If, as seems probable, they represent a more advanced stage of Sphaeropsis common on hickory nuts that species should be called *Diplodia pericarpii* (Schw.). We do not think it possible or wise to give, at present, a specific name to this *Diplodia.* Cfr. Grove, Mycological Notes, Journ. Bot. 57: 206–210 on the stages through which *Diplodia* spores pass.

LEPTOSTROMATACEAE.

22. **Discosia artocreas** (Tode) Fr. Syn. *Discosia faginea* Lib. On hickory nuts, Lyndonville, N. Y., April and May, 1919, Fairman. On hickory nut shuck, Ithaca, N. Y., 1919. On beechnuts, Lyndonville, N. Y., June, 1920. Plate 16, fig. 2.

23. **Dinemasporium hispidulum** (Schrad.) Sacc. On hickory nuts, Lyndonville, N. Y., May 13, 1920. Fairman.

24. **Dinemasporium Robiniae** Ger. Syn. *Dinemasporium*

acerinum Peck. What appears to belong here was collected at Lyndonville, N. Y., May, 1919, by Fairman, Wright and Gray on the inner walls of a squirrel gnawed hickory nut and has pycnidial setae 85 x 3–4 μ. The spores measure 4–7 x 0.5–1 μ.

MELANCONIACEAE.

25. **Pestalozzia nucicola E. & E.** Acervuli immersed, becoming erumpent and finally rupturing, minute, 150–250 μ in diam.; spores oblong fusoid, 4–septate, scarcely constricted, terminal cells hyaline and conical, the inner cells brown, while the entire spore, exclusive of the setae measures 13.3 to 17.66 x 4–5 μ, the colored portion by itself has dimensions of 12–13.33 x 4–5 μ, apical cell crowned with a crest of 3 spreading cilia about 7–10 μ long, lower cell attenuated into a short pedicel. Plate 16, fig. 4. On hickory nuts, Newfield, N. J., May 20, 1893 and May 15, 1894 by J. B. Ellis. We have examined the two collections in the Ellis collection at the New York Botanical Garden and take the one collected May 1893 as the type for it has a description of the fungus in the handwriting of Ellis. The figure was drawn from an original specimen. Saccardo in Syll. Fung., Vol. XI, p. 578 gives the spore dimensions as 12 x 4, but this evidently applies only to the colored part of the spore. This species has also been collected by Roy Latham at Orient, Long Island, N. Y. in 1919.

26. **Pestalozzia nuciseda** sp. nov. Acervuli gregarious, erumpent, black, often shining at the apex; spores broad ellipsoid, 1–3-septate, scarcely constricted at the septa, the first formed septum situated at the middle of the spore, the other two formed later and placed near the extremities, 4-locular, the two middle cells dark brown and often one to two guttulate, terminal cells minute and subhyaline, 12–18 x 7–8 μ, apical cell armed with one to three hyaline, simple or branching cilia about as long as the spores. Plate 16, fig. 5. On nuts and nut shucks of Hicoria, Lyndonville, N. Y., May 1919, C. E. Fairman. *Pestalozzia nucicola* E. & E. is 4-septate, with septa differently situated. *Pestalozzia nuciseda* has broader spores. A comparison of the figures will best reveal the diagnostic features.

TUBERCULARIACEAE.

27. **Tubercularia carpigena** Corda, Ic. Fung. I, p. 4, fig. 64. On horse-chestnuts, lying on the ground, in lawns, Lyndonville, N. Y., July 1920, Fairman. This is the typical form with sporodochia of a more delicate roseate tint than those of T. vulgaris. Provisionally we have referred several Tubercularia-like forms on hickory nuts to this species. Said to be a state of *Nectria Hippocastani* Allesch. The original spelling of the specific name in Corda's Icones is *carpigena,* not *carpogena* as Saccardo has it in Syll. vol. 4.

28. **Volutella ciliata** (A. & S.) Fries. On chestnuts, Europe.

29. **Volutella caryogena** sp. nov. Sporodochia turbinate or turbinate-applanate, pale stramineous, scattered or gregarious, 500 μ or upward in diameter, surrounded by spreading or interwoven white setae which are mostly smooth but at times slightly roughened, obtusely rounded at the tips, double walled, sparingly septate, about 200–500 x 3–7 μ; spores oblong cylindric, straight, obtuse at apices, simple, continuous, hyaline, apparently borne on slender hyaline sporophores. Plate 16, fig. 3, a, b, and c. On nuts and shucks of *Hicoria,* Lyndonville, N. Y., May 18, 1919, Fairman, Wright and Gray. Distinguished by its turbinate form, very long setae, and straight cylindric spores from *Volutella fusarioides* Penz. and *Volutella conorum* E. & E. to the latter of which it seems to come nearest.

30. **Fusarium roseum** Link. On hickory nuts, Lyndonville, N. Y., 1919, Fairman. On cherry pits, Lyndonville, N. Y., JuJly 1920, Fairman. On horse-chestnuts same locality. What appears to be the same thing is found often at Lyndonville, on branches and nuts of black walnut and butternut trees, although the latter may be referable to *Fusarium juglandinum* Peck.

31. **Fusarium nucicola** Karst. & Har. Reported on black walnuts from France and Italy, but we have seen no American specimens.

32. **Epicoccum purpurascens** Ehrenb. On hickory nuts, Lyndonville, N. Y., Oct. 1919, Miss Clara Gray.

HYPHOMYCETEAE.

33. **Cylindrium gossypinum** sp. nov. Clusters effused, very lax or fluffy, elevated in cottony tufts; white; conidiophores not seen or not distinct from the conidia; spores straight cylindric, not attenuated at the ends, often with a minute shining nucleolus at each end, continuous, hyaline, 8.5–12 x 1.5 μ. On the inner walls of a cracked hickory nut, lying on the ground in the woods, Lyndonville, N. Y., Oct. 7, 1919, Wright and Gray.

34. **Penicillium crustaceum** (L.) Fries. Several species of *Penicillium* are universally found on old, musty or decaying nuts, either on the ground or exposed for sale, including the composite form listed under the name above cited. Since the species of this genus can only be satisfactorily differentiated after cultures have been made, studied and compared we are not able to give their names.

35. **Monosporium avellaneum** sp. nov. Clusters scattered in lax, cottony tufts which are pallid white to pale avellaneous in tint; mycelial hyphae decumbent, repent, sparingly septate, hyaline, about 7 μ in width; conidiophores ascending, branched, hyaline, the ultimate branches 3.33–4 μ wide, subobtuse at the ends, bearing 1 or rarely 2 subglobose conidia which are hyaline, 1–3 guttulate, often granular, about 6.66–7 μ in diameter. Plate 19, fig. 5 and 6. On old butternuts, *Juglans cinerea* fruit, Lyndonville, N. Y., July 20, 1920, Charles E. Fairman.

36. **Trichothecium roseum Link.** On a hickory nut and shuck, Lyndonville, N. Y., Oct. 29, 1919, Miss Clara Gray.

37. **Trichothecium candidum** Wallr. On pericarp of black walnut, Italy.

38. **Septocylindrium nuculinum** sp. nov. Spore heaps scattered, minute, subpulvinate, resembling white flecks; spores cylindric, rounded at the ends, often attenuated toward the extremities, single or catenulate, granular at first, becoming 1 to 3 septate, hyaline, 17–25 x 3–4 μ; sporophores invisible. Plate 16, fig. 9. On hickory nut shucks, Ithaca, N. Y., Cornell University Campus, May, 1919, George Hume Smith. Accompanied by a *Vermicularia* and a *Helminthosporium* with the following characters: spores fuliginous, oblong, 9–12-septate, 80–130 x 40 μ, with a long hyaline pedi-

cel at one end, and frequently hyaline cuspidate at the other. Plate 16, fig. 10. We await more abundant specimens before giving it a name.

39. **Dactylaria echinophila** Mass. On the spines of the capsules of *Castanea sativa*, Italy.

40. **Coniosporium nucifoedum** sp. nov. Spore heaps rounded, pulvinate or indefinitely effused, black; spores globose or ellipsoid, simple, continuous, dark olivaceous to brown, black or opaque, with a darker rim or cell wall, 6–7 x 3.33–7 μ. On a hickory nut, Lyndonville, N. Y., May 18, 1919, Fairman, Wright and Gray. Plate 16, fig. 7.

41. **Fusella olivacea** (Corda) Sacc. Syll. IV. 246. Lindau, Hyphom. p. 565; Ferraris, Flora Ital. Cryptogama, *Hyphales*, p. 212 and fig. 55. *Fusidium olivaceum* Corda, Icones, I, p. 3. Spore heaps rounded, pulvinate, scattered, black; spores fusoid or ellipsoid, olivaceous, 1–2 guttulate, or at times eguttulate, about 10 x 4 μ. Sporophores absent. Plate 19, figs. 7 and 8. On beechnuts, woods, Lyndonville, N. Y., July 15, 1920, C. E. Fairman. The original description by Corda reads "*Fusidium olivaceum;* Tab. I, fig. 53. acervulis subeffusis olivaceo-atris, decolorantibus, sporis majusculis oblongis utrinque obtusis, olivaceis, semipellucidis." In the descriptions by Saccardo, Corda, Lindau and Ferraris no spore measurements are given. Neither Corda's figure nor the one in Flora Ital. Crypt. show any attempt at nuclear definition.

42. **Acrospeira mirabilis** B. & Br. On chestnuts, England and Italy.

43. **Helicotrichum obscurum** (Cda.) Sacc. Hyphae dark, circinate and denticulate at the lighter colored apices; spores hyaline, oblong or subfusoid and curved, 14–17 x 1 μ. On hickory nuts, Lyndonville, N. Y., Aug. 1919, Miss Clara Gray; on pits of cultivated cherry, Lyndonville, N. Y., July, 1920, C. E. Fairman; on pits of wild cherry, banks of Oak Orchard Creek near Point Breeze, N. Y., Aug. 1, 1920, Miss Clara Gray.

44. **Menispora ciliata** Corda. On a beechnut in the woods, on ground, Lyndonville, N. Y., July 15, 1920, C. E. Fairman.

45. **Bispora monilioides** Corda. On black spots on a hickory nut, Lyndonville, N. Y., May 17, 1919, Dr. L. B. Wright and Miss Clara Gray.

46. **Fusicladium effusum** Wint. On three varieties of cultivated pecans from Jacob's Grove, Orlando, Fla., comm. Dr. C. L. Shear. Causing a serious disease to the pecan grower, which is called pecan scab. It stunts the growth of the nuts and if abundant causes them to drop. A description of the disease may be found in Bulletin 49 of the Georgia State Board of Entomology, p. 38–43 with Plate XIV.

47. **Helminthosporium rhopaloides** Fres. Tufts effused, olivaceous black, resting often on a pale green substratum; conidiophores brown, septate, erect; spores obclavate, 44–67 x 7–10 μ, 7–9 septate and with a nucleus in each cell. Plate 16, fig. 8. The spores are often more attenuate and running to an acute tip than represented in those figured. On hickory nut, Lyndonville, N. Y., May, 1919, Fairman, Wright and Gray. Other *Helminthosporium* species doubtless grow on old nuts but have not been specifically identified.

48. **Sarcinella heterospora** Sacc. On hickory nuts, Lyndonville, N. Y., 1919, C. E. Fairman. Plate 16, fig. 11, a and b. Hyphae aggregated in brown or black felted masses on both the exterior and interior of the nuts, flexous at the tips, about 4 μ wide, roughened, with septa placed 17–27 μ apart, often with abundant clamp connections of the component compartments, bearing dimorphic spores. In our specimens the hyaline falcate, triseptate conidia, measuring 17–24 x 4.5–5 p, are well developed, while the dark colored, sarciniform spores are found in the stage where they have developed from one to two septa, becoming quadrilocular as shown in the illustration. The hyaline spores are smaller than usually stated. Ellis and Everhart, in North Amer. Pyrenomycetes, page 31, say that it is quite common west and southwest "on leaves of *Cornus, Fraxinus* and other trees" but we have seen no previous record of its presence on nuts.

49. **Helicosporium cinereum** Peck. On hickory nut shucks, Lyndonville, N. Y., 1919, Fairman.

50. **Helicosporium olivaceum** Peck. On hickory nuts, Lyndonville, N. Y., Fairman.

PYRENOMYCETEAE.

51. **Microsphaera Alni** (DC.) Wint. In the pecan belt. Causes mildew of pecans.

Schizocapnodium gen. nov. Perithecia situated in or covered by a black mycelial crust, hemispheric, apparently ostiolate, black; asci cylindric, fusoid, or clavate, 4–8 spored, aparaphysate; sporidia ellipsoid or subglobose, concavo-convex or pomiform, cruciform septate, with a single longitudinal and a single tranverse septum at right angles to each other, sometimes with the transverse septum situated lower in one spore half than in the other when the spore halves are not symmetrically approximated, at times with more than one transverse septum, compound and readily splitting longitudinally, at least outside the asci, and dividing into two ellipsoid, uniseptate or biseptate halves, brown or black.

52. **Schizocapnodium sarcinellum** sp. nov. Perithecia scattered or gregarious, aggregated in a black mycelial crust, globose or globose-conoid, base somewhat flattened, slightly roughened, apparently with small, slightly protuding ostiola, dull black, 300 to 500 μ in diameter; asci cylindric or clavate, 55 to 100 μ, or upward, in length by 13.33 to 14 μ in breadth, usually 4-spored, possibly sometimes 6 or 8 spored, readily diffluent; paraphyses indistinct or absent; sporidia uniseriate, broad ellipsoid to subglobose, sides convex, ends slightly concave, i. e. concavo-convex or pomiform, cruciform septate, or with one to two longitudinal septa and one or two transverse septa, sarciniform, sometimes with the transverse septa irregularly situated in case the spore halves are not symmetrically approximated, dividing, at least outside the asci, longitudinally into two ellipsoid, uniseptate or biseptate halves, one half sometimes projecting at the apex of the spore in an acuminate manner, hyaline and 4-magniguttulate at first, becoming brown or black, sometimes nearly opaque with age, 13.33–17 x 10 μ. Plate III, fig. 1, a and b. This interesting fungus was found in the woods of the William Grimes estate at Lyndonville, N. Y., on a single hickory nut, lying on the ground under Hicoria trees by Miss Clara Gray on Oct. 19, 1919. The crust seems to be composed of mycelial threads which are brown, septate, straight or curving, sometimes branching, 6.66 μ in width and at least 100 μ in length. The systematic place of the genus is not clear to the author. Its affinities seem to be with the *Capnodiaceae,* but a study of more abundant specimens may cause it to be placed among the

Sordariaceae, Clypeosphaeriaceae or some other family of the true *Sphaeriaceae*.

53. **Guignardia echinophila** (Schw.) Trav. 1906. Syn. *Sphaeria echinophila* Schw. Syn. fung. Amer. bor. no. 1755, 1831; *Sphaeria echinophila* Ces. Unio. itin. crypt. no. XXI; *Sphaerella echinophila* Awd. Myc. Eur. Heft V–VI, p. 3; *Laestadia echinophila* (Ces.) Sacc. Syll. I, 425 and XI, p. 291, 1882; *Laestadia echinophia* (Schw.) E. & E., N. A. pyr. p. 291, 1892; *Guignardia echinophila* (Schw.) Trav. Flora ital. crypt, Sphaeriales, p. 391, 1906; Exsiccati. Ellis, N. Am. Fungi, 758; Marcucci, Unio itineraria cryptogamia no. XXI, 1866; Icon. Awd. loc. cit. Tab. VII, fig. 103. On chestnut burs, probable wherever chestnuts grown.

54. **Phomatospora phomatospora** (B. & Br.) Schröter. Syn. *Sphaeria phomatospora* B. & Br. *Phomatospora Berkeleyi* Sacc. On pits of cultivated cherries, on the ground under cherry trees, Lyndonville, N. Y., July 20, 1920, C. E. Fairman. Asci straight cylindric, with a prolonged filiform stipe, 50–85 x 3.33–3.50 μ; paraphyses absent; spores fusoid, uniseriate, or overlapping uniseriate, biguttulate, hyaline, 6–7 x 1.5–2 μ. This is a new host for this sp.

55. **Glomerella cingulata** (Stonem.) S. V & S. On pecan nuts in the pecan belt. Produces the disease called anthracnose, manifested by irregular, black, sunken spots on the affected nuts and causing a heavy dropping of premature nuts.

56. **Chaetomium globosum** Kunze. On nuts of Hicoria sp., Ridgeway, N. Y., May 10, 1919, C. E. Fairman.

57. **Coniochaeta ligniaria** (Grev.) Trav. Rosellinia auct. On hickory nuts, Lyndonville, N. Y., May, 1919, Fairman, Wright and Gray.

58. **Xylaria carpophila** (Pers.) Fr. On hickory nuts, N. Y. State, S. H. Burnham, comm. C. G. Lloyd. What appears to be the *Isaria* or conidial stage of this species was found at Lyndonville, N. Y., on hickory nuts May, 1919, by Fairman, Wright and Gray. Synnema white when fresh turning brown with age, villose; spores globose, hyaline, minute, about 1.5 μ in diam. Plate 20, figs. 1 and 2.

59. **Didymella nucis-hicoriae** sp. nov. Perithecia minute, thickly scattered over the surface, immersed becoming erumpent

and subsuperficial, hemispheric or conic-hemispheric, base sunken in the matrix and leaving a minute depression when picked out, dull black, with polished glistening apices; asci clavate-cylindric, rounded at the apex, sessile or short stipitate, 8-spored, 95 x 10–13 μ; sporidia biseriate, at times uniseriate, fusoid, uniseptate, deeply constricted at the septum, with 4 large guttulae, the upper cell and sometimes the lower one also abruptly enlarging above or below the septum, hyaline, 20–28 x 6–7 μ. Plate 18, fig. 6, a and b. On nuts of *Hicoria* sp. overwintered and lying on the ground in a lawn, under hickory trees, Lyndonville, N. Y., April, 1919, Charles E. Fairman. On hickory nuts, same locality, May, 1919, Dr. L. B. Wright and Miss Clara Gray. Resembles *Didymella fructigena* E. & E. but has larger spores. The specimens collected by Wright and Gray have the perithecia immersed in a discolored area and are accompanied by a brown mucelial growth.

60. **Didymella fructigena** E. & E., N. Am. Pyr. p. 319, 1892. On cherry stones lying on the ground, Newfield, N. J., Ellis.

61. **Melanopsamma abscondita** E. & E. N. A. Pyr. p. 177. On hickory nuts, Newfield, N. J., Sept. 1890, Ellis. On account of the spores becoming triseptate this should be called *Zignoella abscondita* (E. & E.).

62. **Melanopsamma Amphisphaeria carpogena** var. nov. Perithecia globose or globose-conoid, superficial, gregarious or confluent, externally slightly roughened, black, 300 μ in diam.; asci 8-spored, cylindric, sessile or short stipitate, 120–144 x 13.33–18 μ; sporidia uniseriate, elliptical, uniseptate, constricted deeply at the septum, obtuse at the ends, often with one-half broader than the other, granular or with occasional small nuclei, hyaline to subhyaline, 20–24 x 8–10 μ; paraphyses filiform. On hickory nuts, Lyndonville, N. Y., May 18, 1919, Fairman, Wright and Gray. Differs from typical *Melanopsamma Amphisphaeria* Sacc. & Schulz in having slightly roughened perithecia and larger spores. The habitat is also different. Illustration in Flora Ital. Crypt., Sphaeriales, fig. 111, page 682. There are also associated pycnidia filled with bacillar, hyaline spores, 4–6 x 0.5–1 μ, a species of *Aposphaeria*. In Fl. Ital. Crypt. loc. cit. Italian specimens of this species are said to be accompanied by Aposphaeria. Von Höhnel,

sec. Strasser in Annales Mycologici 9:81, refers *M. Amphisphaeria* to *Didymella.*

63. **Melanopsamma subrhombispora** sp. nov. Perithecia scattered, immersed becoming superficial, globose-conoid, base flattened and adnate leaving a small depression surrounded by a small black ring when removed from the nut surface, with minute, shining, papilliform ostiola, slightly roughened externally, black, 100–200 μ in diameter; asci clavate-cylindric, rounded at apex, sessile or short stipitate, surrounded by filiform paraphyses; sporidia irregularly biseriate, fusoid, biconic, acute at apices, with from 2 to 4 small oil-drops, for a long time continuous, probably becoming uniseptate, hyaline, 10–13.33 x 3–3.33 μ. Plate 19, fig. 4. On a beechnut, Lyndonville, N. Y., May 12, 1920, C. E. Fairman.

64. **Endothia parasitica** (Murr.) A. & A. On burs and nuts of chestnut trees, Pennsylvania, J. F. Collins, 1912, and Caroline Rumbold, 1913. This is the chestnut blight, chestnut canker or chestnut bark disease which, according to the above named collectors, has been found on old fruits of chestnut. Its occurrence is discovered from blister like excrescenses on the nuts.

65. **Diaporthe (Tetrastaga) Nucis-Avellanae** Feltgen. Feltg. Vorstud. Pilz. Luxemb. 1901, Nachtr. II, p. 121; Saccardo, Syll. Fung. XVII, 673. On nuts of *Corylus Avellana,* Luxemburg.

66. **Didymosphaeria nuciseda** sp. nov. Perithecia scattered, immersed then erumpent, becoming subsuperficial with the base sunk in the matrix up to one-half the height, closely embraced by the remnants of the ruptured sclerenchyma, globose, black, 350–600 μ in diameter; asci cylindric, rounded at the apex, short stipitate, 6–8 spored, 75–85 x 10 μ, surrounded by numerous slender paraphyses; sporidia uniseriate or at times biseriate above and uniseriate below, ellipsoid, uniseptate, when young with a gutta in each cell, not markedly constricted, light brown at first, later becoming dark brown, 11–18 x 6–7 μ. Plate 17, fig. 2. On hickory nuts, Geo. A. Porter farm, Albion, N. Y., May 25, 1919, Miss Lucy Porter and Miss Clara Gray. The spores average 10–14 x 6 μ but spores have been found which measure 18 μ in length. The long spore is often found at the base of the ascus near the stipe while the seven spores above are of normal length.

67. **Rhyncostoma nucis** sp. nov. Perithecia gregarious,

globose or globose-conoid, erumpent-superficial, with tapering, or sometimes abruptly rising, cylindric, bare black beak as long or sometimes longer than the body of the perithecia, black, 500 μ or more in height and 300 μ or more in breadth; asci 8-spored, cylindric, usually long stipitate, 90–130 x 12–13.5 μ, surrounded by slender paraphyses greatly exceeding the asci in length; sporidia fusoid, uniseptate, constricted at the septum, biseriate, or rarely uniseriate, at first hyaline and two to four guttulate, remaining a long time in this condition, gradually becoming pale vinous or light reddish brown, sometimes pale olivaceous, 17–20 x 4.5–6 μ. Plate 17, fig. 4. On a hickory nut overwintered among leaves in a bed of daffodils, Lyndonville, N. Y., April, 1920, C. E. Fairman. Whether the spores become darker or more septate with age cannot be definitely stated. Specimens kept out of doors under similar conditions for a long time showed no marked changes. Not rarely spores are seen with one-half longer and more acute than the other.

68. **Amphisphaeria nucidoma** sp. nov. Perithecia gregarious, rarely scattered, superficial or with the base only slightly sunken in the nut surface, globose, with obtuse protruding ostiola, somewhat roughened, dull black, 500 μ and upward in diameter; asci clavate-cylindric, rounded at the apex, moderately long stipitate, octosporous, 200 x 18 μ, paraphysate; sporidia uniseriate, ellipsoid, uniseptate, constricted at the septum, obtusely rounded at the ends, brown, 24–30 x 13.3–17 μ. Plate 17, fig. 3. On a hickory nut, Lyndonville, N. Y.. 1919, C. E. Fairman.

69. **Zignoella nucivora** sp. nov. Perithecia gregarious, rarely scattered, globose or globose-conoid, sometimes collapsing, externally slightly roughened, immersed at first then becoming superficial, dull black, with shining papilliform ostiola, 300–350 μ in diam.; asci clavate-cylindric, octosporous, short stipitate, 80–100 x 8–10 μ, paraphysate, sporidia irregularly biseriate, fusoid or ellipsoid, attenuated and subacute at the ends, at times inequilateral, tri-septate, not constricted at the septa, hyaline or subhyaline, often 4-guttulate, 17–24 x 5–7 μ. Plate 17, fig. 9. On hickory nuts, George A. Porter farm, Albion, N. Y., May 20, 1919. Dr. Leon B. Wright, Miss Lucy Porter and Miss Clara Gray. Another collection was made at same locality by Miss Porter in June, 1919.

70. **Herpotrichia macrotricha** (B. & Br.) Sacc. Syll. 2:213. On nuts of *Fagus,* Germany, see Lindau in Hilfsbuch.

71. **Rhynchosphaeria nucicola** sp. nov. Perithecia scattered, globose, base slightly sunk in the matrix, with prominent, prolonged, cylindric, beak-like ostiola, black, 500 μ and upward in diam.; asci cylindric or clavate, 8-spored, short stipitate, rounded at the apex, 110–117 x 13–14 μ, paraphysate; sporidia biseriate, fusoid, straight or curved, 5–7 septate, constricted at the septa, each loculus often guttulate, middle cells larger, sometimes with one of the middle cells enlarged, 30–37 x 7–8 μ. Plate 17, fig. 8, a, b. and c. Sparingly found on a hickory nut on the banks of Johnson Creek, Blood's Bridge, Yates, Orleans Co., N. Y. by Charles E. Fairman and Miss Helena A. Phelps, May 13, 1919. Also on a beechnut, in the woods, Lyndonville, N. Y., June, 1920, C. E. Fairman. The spores bear some resemblance to those of *Melanomma hydrophilum* Karst. sec. Berlese, Icones Fungorum, Tab. XXIV, f, 4, but the perithecia seem different.

72. **Leptosphaeria exocarpogena** sp. nov. Perithecia thickly scattered, immersed then erumpent, becoming subsuperficial, globose, centrally ostiolate, black, 200–250 μ in diam.; asci cylindric, 8-spored, 78–93 x 7–8 μ, paraphysate; sporidia biseriate, oblong-fusoid to biconic, triseptate, constricted at the middle septum, but not markedly at any of the other septa, hyaline, then becoming yellow or brown, 23–27 x 3–4 μ. Plate 17, fig. 5, and Plate IV, fig. 1. On a shuck of hickory nut, under *Hicoria* trees, flats along Johnson Creek, Gambell farm, Lyndonville, N. Y., May 1, 1919, C. E. Fairman. When the spores are biconic they resemble those of *Leptosphaeria Parietariae* Sacc. as figured by Berlease in Ic. Fung. Tab. XLVI, f. 2.

73. **Leptosphaeria cacuminispora** sp. nov. Perithecia scattered or gregarious, immersed at first, becoming erumpent, often imbedded in débris on the surface of the nut, covered at times, except at the apex, with a brownish tomentum, globose or globose cenoid, papilliform ostiolate, black, 200–250 μ in diam.; asci clavate-cylindric, octosporous, straight or curved, long and narrow, about 90–135 x 6–10 μ, thickly interwoven and separable with difficulty, surrounded by filiform paraphyses which are at times enlarged at apices and usually exceed the asci in length; spores overlapping

uniseriate, sometimes biseriate, fusoid, 3–7–septate, constricted at the middle septum, one or two of the middle cells often globose enlarged, end cells longer and very sharp pointed or acute, pale brown or yellowish brown, 27–30 x 3–5–4 μ. Plate 17, fig. 7. On hickory nuts, Lyndonville, N. Y., Apr. 1919, C. E. Fairman. Distinguished by its long, narrow asci, and acute spores.

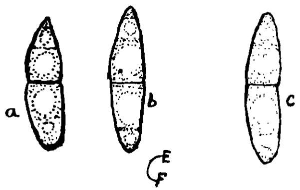
74. **Leptosphaeria Lyndonvillae** Fairman. Plate 17, fig. 6. On hickory nuts, Lyndonville, N. Y., 1919, C. E. Fairman. Originally found on old locust pods. For a discussion of the species consult Fairman, Pyrenomyceteae novae in leguminibus Robiniae, Annales Mycol. vol. IV, p. 327 and fig. 1, 1906.

75. **Caryospora putaminum** (Schw.) De Not. Plate 19, fig. 3. *Sphaeria putaminum,* Schw. Syn. Fung. Carolinae superioris,, in Schr. Nat. Ges., Leipzig, 1822, p. 43, no. 163. Fries. Syst. Mycol. vol. 2, p. 461–462, Tribe XX, Pertusae, 1822. De Notaris, Micr. Ital., Dec. IX, 1855. Saccardo, Fungi Veneti, Series III, p. 8 and Syll. Fung. 2: 122. Berlese, Icones Fungorum, p. 26. Ellis and Everhart, North Amer. Pyrenomycetes, p. 209. Illustrations: Saccardo, Fungi Italici, tab. 201. Berlese, Icones Fung. tab. XVI, fig. 1. Ellis and Everhart, N. Am. Pyr. plate 24. Underwood, Moulds, Mildews, etc., plate IV, fig. 15; Cooke, Fungi, etc., Internat. Sc. Ser., fig. 78 (spore x 400). Icon. nostr., plate 19, fig. 3, and Plate 20, fig. 4. Exsiccatum: Ellis, N. A. F. no. 898. Habitat. On peach pits, common in the peach region. On hickory nuts, Starksville, Miss., J. S. Moore, 1895 and S. M. Tracy, 1896. On hickory nut shell, Scottsburg, Indiana, J. R. Weir, no. 5196, Nov. 12, 1917, in the herbarium of Prof. H. M. Fitzpatrick, labelled *Caryospora minor* Peck. The Indiana specimens have evidently been misdetermined for the perithecia and spores are like those of Caryospora putaminum. This species, the most memorable of all the nut fungi, has an interesting history. Originally collected by Schweinitz in North Carolina and published by him as Sphaeria putaminum, it was soon included by Fries in Syst. Mycol. in the section Pertusae. Neither Schweinitz nor Fries seem to have made any microscopic examination of it, for they do not record any spore measurements or characters. Schweinitz was evidently impredded with the gross appearance of the fungus for he mentions its large size, ampulliform neck with dilated apex, and other fea-

tures. De Notaris, having received a small specimen of it from Berkeley, compared it with his Sphaeria nucleria on olive pits and decided that the species of Schweinitz belonged to a new genus which he called Caryospora. De Notaris could not find asci and concluded that the spores originated directly from the applanate base. To De Notaris, however, belongs the credit of first observing the microscopic spore characters. Saccardo collected the ascigerous form on a decaying peach pit at Padua, Italy. He described the asci and spores in Fungi Veneit, loc. cit. In Sylloge Fungorum, vol. 2 Saccardo emended the genus Caryospora and placed it among the Pyrenomycetes.

76. **Caryospora minor** Peck. Peck, 44th Rep. N. Y. State Mus. p. 29 and plate 4, figs. 18–21, 1891.

On pericarp of hickory nuts, Albany, N. Y., Peck. Through the kindness of Dr. Homer D. House, State Botanist, we have had the privilege of examining the type specimens and have illustrated the species in plate 19, fig. 1, and plate 20, fig. 3. We have also examined a portion of the type in the herbarium of Prof. H. M. Fitzpatrick of Cornell University. The spores were originally described by Dr. Peck as "fusiform, pointed at each end, uniseptate and slightly colored." Spores stained in a solution of equal parts of glycerine and camphor water tinged with erythrosine show that they became 3–5 pseudoseptate and sometimes slightly constricted at the middle septum. The end of the stained spores and each side of the septa are filled with erythrosinophile granules, while the interior of the loculi is occupied by globose, hyaline nuclear bodies.



Figs. a, b and c. Spores of *Caryospora minor* Pk., stained with erythrosine.

The paraphyses, of which no mention is made in the original description, are filiform, exceeding the asci in length and not readily seen except in stained specimens. The specimens at hand are perhaps not mature judging from the pale color of the spores and their pseudoseptate appearance when stained. It may prove to be a *Melanomma* or *Trematosphaeria*. The spores lack the true snout-like prolongation of *Caryospora* spores, and do not seem to be involved in mucus.

77. **Melanomma caryophagum** (Schw.) Syn.

Sphaeria caryophaga Schw. Syn. Amer. bor. n. 1594. Trans. Amer. Phil. Soc., 2, p. 215. Sacc. Syll. vol. 2, no. 4332.

Sphaeria nuclearia De Not. Micr. Ital. Decade IX, no. 4, fig. 4, 1855. Auct. Amer. p. p.

Sphaeria Curtisii, Berk. Curtis, Cat. p. 145. Nomen nudum.

Sphaeria caryophaga Schw. in Berkeley, Notices of North Amer. Fungi, 1872 et seq. p. 185. On Carya, Carol. inf. no. 6032.

Hypoxylon nucitena B. & C., Berkeley, Not. North Am. Fungi, no. 844, Grevillea, Sept. 1875, p. 52.

Melanomma nucitena (B. & C.) Sacc. Syll. 2: 103, 1883.

Caryospora nuclearia (De Not.) Thuemen.

Trematosphaeria nuclearia (De Not.) Sacc. Syll. 2: 121, 1883.

Trematosphaeria nuclearia (De Not.) E. & E., N. Am. Pyr. p. 207, 1892.

Trematosphaeria caryophaga (Schw.) Sacc. Syll. IX, 813, 1891.

Melanomma nuclearium (De Not.) Berl. Ic. Fung. p. 35, 1891.

Melanomma Minervae Fabre, Sph. Vaucl., p. 91, f. 26, fide Berlese, loc. cit.

Illustr. Berlese, Icones Fung. tab. XXIII, figs. 2 and 3, p. p. Habitat: On nuts of *Carya alba* and *tomentosa*, Bethlehem, Pa., Schweinitz; on nuts of *Hicoria*, North Carolina, Curtis; on same host from following localities: Pennsylvania, Dr. Michener; Orient, N. Y., Roy Latham; Kittery Point, Maine, Sept. 1919, Prof. Roland Thaxter; High banks of the Genesee River, near Mount Morris, N. Y., July 11, 1920, Miss Clara Gray; Pennsylvania, Everhart; also specimens in the Ellis Collection at the N. Y. Botanical Garden from Pa. and Mo., date and locality not given.

We have not accepted the genus *Trematosphaeria* as distinct from *Melanomma.* The basing of a genus upon size and pertusate apex seems insufficient. The latter character is often a condition of age and consequent deciduousness of the neck or ostiolum. This species on hickory nuts has been called in recent years *Trematosphaeria nuclearia* (De Not.) and has been supposed to be identical with a fungus found in Europe on olive pits. The different habitat renders this supposition open to doubt. Plate 18, fig. 5 was drawn from a specimen on olive pits from Liguria, taken from Erb. Critt. Ital. Series II, labelled *Melanomma nuclearium.* On the olive the the perithecia are generally scattered, sometimes gregarious, and we have never seen them crustose-aggregated. Plate 18, fig. 4 shows the appearance of the *Melanomma* on hickory nuts collected at Mount Morris, N. Y. Specimens from Prof. Thaxter, collected at Kittery Point, Maine, have the perithecia so close that an almost continuous crust results. If Berkeley had similar forms before him it need excite no surprise that he should have named it *Hypoxylon nucitena.* Again, the spores of the species in question, upon our hickory nuts, seem to be smaller than those on the olive pits, as a reference to Plate 17, will show. Fig. 11 represents the spores from the specimens in Erb. Critt. Ital., while fig. 10a shows the spores of specimens from Kittery Point, Me. and 10b slightly larger ones from Mt. Morris, the two last being on hickory nuts. Basing our opinion upon different habitat, dissimilar appearance of perithecia upon the hosts and smaller, though similar, spores we think that the specimens of *Melanomma* upon our American hickory nuts are referable to a distinct species. In regard to the specific name chosen we have the following to offer. The original description of Schweinitz, loc. cit., seems to fit the species under discussion. It reads "S. gregaria, regularis, mediocri magnitudine, plagas formans aterrimas subexpansas in nucibus; peritheciis dimidiatis ex hemisphaerico subconicis, basi crusta nigra, inter se connexis tenui, papillatis, demum pertusis." We have not been able to examine the specimens of Schweinitz, Curtis, or Michener. Dr.

C. L. Shear, who has been engaged in examining the Sphaerias of the Schweinitz herbarium writes as follows: "I regret to say that in our studies of the fungi in the Schweinitz herbarium we have not yet reached Sphaeria caryophaga and I am not sure at present whether his collection contains a specimen of this species. Some of the species are missing. The opinion of Cooke in regard to the identity of this species was probably based upon authentic specimens which are found in the Kew herbarium and may perhaps be correct, unless as is sometimes the case, Schweinitz included more than one species in his collection." At present the best that the writer can do is to accept the uncorroborated statement of Cooke in Grevillea, XVIII, p. 60, March 1890. He says loc. cit. "from authentic specimens of Schweinitz, Berkeley and Curtis, and the figure and description of De Notaris we are satisfied that the above are all one species." The specific name *caryophaga* antedates that of *nuclearia,* by De Notaris.

78. **Sporormia leptosphaerioides** Speg. Syn. *Sporormia leporina var. Pruni spinosae* Kunze, Fungi sel. exsicc. no. 273. On hickory nuts, May 1919, and on a nut of black walnut, June 1920, Lyndonville, N. Y., Fairman. Berlese says that this is found in Germany on cherry pits. Plate 19, fig. 9. In the specimen on black walnut the perithecia are globose, papillate, black, 250 μ in diam.; Asci clavate-cylindric, short stipitate, 8-spored, 100 x 13.5–17 μ; spores fusoid, quadrilocular, brown, 33–35 x 6–7 μ, terminal cells conical, inner cells subglobose.

79. **Teichospora nucis** E. & E., Proc. Acad. Nat. Science, Philad. 1893, p. 446. Sacc. Syll. Fung. 11:345. On old nuts of *Hicoria,* Newfield, N. J., Ellis. Plate 18, f. 2 drawn from an original specimen in the Ellis collection.

80. **Nectria Hippocastani** Allesch. Suedbay. Pilz. p. 160, t. 1, f. 2. Sacc. Syll. IX, 961–962. On fruit of *Aesculus* near Munich, Bavaria. What appears to be the *Tubercularia* stage of this has been found at Lyndonville by the author.

81. **Gibberella saubinetii** (Mont.) Sacc. On a hickory nut in a lawn, underneath a hickory tree, Lyndonville, N. Y., May 7, 1919, C. E. Fairman.

82. **Glonium caryigenum** E. & E., N. Am. Pyr. p. 682. On

old nuts of *Hicoria,* Newfield, N. J., Ellis. Plate 18, fig. 3, from an original specimen in the Ellis collection.

83. **Lophiosphaera pulveracea** Sacc. On a hickory nut lying on the ground among leaves in the author's rose garden, Lyndonville, N. Y., June 6, 1920. Perithecia with compressed ostiola; asci clavate, 50–100 x 6–7 μ, surrounded by filiform paraphyses exceeding the asci in length; sporidia fusoid, hyaline, uniseptate, constricted at the septum, acute at the ends, with a minute hyaline apiculus at each end, 2–4 small guttulate, hyaline, 17 x 3–4 μ.

84. **Lophiotrema crenatum** (Pers.) Sacc. On decaying walnut shucks, Germany. Rehm, Ann. Mycol. 9: 58.

Doubtful or Excluded Pyrenomycetes.

Dothidea missourienis Schw.

Dr. C. L. Shear sends the following information relative to this species: "In regard to the other fungus, Dothidea missouriensis, I have examined a specimen of this so labelled by Schweinitz, it being a part of Schweinitz's original collection found in the herbarium of Michener. Ellis says in his North American Pyrenomycetes, that the specimen in Schweinitz's herbarium which he examined is a thin sterile crust. This describes fairly well the syecimen I have examined. The so-called sterile crust, however, is only a blackening of the tissue of the host, that is, the outer layer of the inner shell of the pecan, which is the host. There are a few fungus filaments intermingled with this dark colored layer and these filaments may belong to Fusicladium effusum Winter which is very common on pecan nuts in the South. Schweinitz's name, however, must I think be regarded as a nomen nudum. as there is no fungus present in condition for examination." Also placed in *Species Phyllachorae delendae* by Theissen and Sydow in their monograph, *Die Dothideales,* page 574.

Hysterographium nucicolum (Schw.) E. & E.

Hysterium nucicolum Schw. We have not been able to examine a specimen of this and Dr. F. J. Seaver, Curator, N. Y. Botanical Garden informs me that he has been unable to find a specimen in the Ellis collection.

DISCOMYCETEAE.

85. **Ciboria echinophila** (Bull.) Sacc. On involucres of chestnuts, Bethlehem, Pa., Schweinitz. Prof. E. J. Durand, Bull. Torr. Cl., July 1902, thinks that this may have belonged to *Ciboria Americana,* which is probably the American representative of the European *C. echinophila.*

86. **Ciboria Americana** Durand. Durand, Studies in North American Discompcetes, Bull. Torr. Bot. Cl., July 1902, p. 461–462. On chestnut burs, Ithaca, N. Y., Oct. 16, 1901. We have examined a specimen in our herbarium from E. J. Durand, North American Discomycetes, no. 1189.

87. **Ciboria Juglandis** Preuss. On hickory nut shucks, Ithaca, N. Y., July 14, 1903. Durand's N. Am. Disc. no. 2279, in my herbarium, is probably this species.

88. **Ciboria nyssogena** (Ellis) Sacc. On old nuts of *Nyssa multiflora,* New Jersey, Ellis.

89. **Phialea fructigena** (Pers.) Gill. On hickory nuts, Lyndonville, N. Y., May to Nov. Common where hickory nuts are found. Found also on beech-nuts, chestnut capsules, and oak acorns.

90. **Helotium humile** Sacc., Mich. 2:78, & Syll. 8:242. Fairman, Fungi Lyndonvillenses novi vel minus cogniti, Ann. Mycol. 8:330, no. 37. On capsules of horsechestnut in Normandy, France. On same host, Lyndonville, N. Y., Nov. 1909, C. E. Fairman.

91. **Helotium herbarum** (Pers.) Fr. On hickory nut shucks, Lyndonville, N. Y., Nov. 1919.

92. **Karschia elaeospora** sp. nov. Apothecia scattered, globose then expanded, finally applanate, sessile, black, margin upturned, 200–650 p in diameter; asci clavate-cylindric, short stipitate, 6–8 spored, surrounded by interwoven paraphyses, 50 x 5–6 μ; sporidia conglobate or biseriate, ellipsoid, uniseptate, one to two guttulae in each half, slightly constricted at the middle, sometimes unconstricted, at first exhibiting a greenish or smoky tint, becoming pale olivaceous, 10–13.3 x 3.5–4 p, iodine reaction positive. On the inner partition walls of a cracked hickory nut, Albion, N. Y., George A. Porter farm, May 25, 1919, Dr. Leon Wright, Miss

Lucy Porter and Miss Clara Gray coll. Also found on the outside of a hickory nut at Lyndonville, N. Y., May 25, 1919, Fairman, Wright and Gray. In the Lyndonville specimens the spores are often inequilateral, with one cell having a more acute end than the other, somewhat resembling a human footprint. The specimens collected at these localities, about 16 miles apart, agree in the olivaceous spores. Plate 18, fig. 7 shows the spores as they usually appear.

EXTRALIMITAL DISCOMYCETEAE.

The following species have been found in Europe and some of them being cosmoplitan may be looked for on our nuts and pits.

On nuts and involucres of *Fagus* sp.

93. **Helotium carpinicola** Rehm.
94. **Pezizella conorum** Rehm.
95. **Lachnum virgineum** (Batsch.)
96. **Arachnopeziza aurelia** (Pers.)

On nuts and involucres of *Aesculus*

97. **Phialea tetraspora** Feltg.
98. **Cyathicula coronata** (Bull.)
99. **Cyathicula fructigena** Feltg.

MYXOMYCETEAE.

100. **Arcyria globosa** Schw. Common on fallen chestnut burs. *Lachnobolus g.*, F. Col. 1100.

MUCORACEAE.

The following **Mucoraceae** have been reported on nuts but the writer has not seen them. They must be considered doubtful.

Mucor echinophilus Schweinitz, Syn. of North Amer. Fungi no. 2742. Reported from Pennsylvania on spines of the involucres of chestnuts. Prof. Sumstine (N. Amer. Mucorales, Mycologia, 2: 152) reports that the original specimens are all gone and that its identity is uncertain.

Mucor Juglandis, Link, Obs. I, p. 18. On rancid nuts of *Juglans regia* in Germany and Belgium. This species also lacks confirmation.

Addendum.

101. **Stachylidium** sp. Acervuli fluffy, mouse colored to dark cinereous; hyphae brown, sparingly septate, verticillately branched; sporiferous branches acute at apices, gradually enlarging toward the base which is often enlarged or dilated and transversely septate, hyaline when young becoming almost as dark as the hyphae with age, branches 3 to 5, crowned with a globose head of agglutinated ellipsoid or subglobose spores which are hyaline, often minutely granular and measure about 3.33–5 x 1.5–3 μ. On pericarp of butternut, *Juglans cinera,* Lyndonville, N. Y., Sept. 19, 1920, Miss Clara Gray. Comes near *S. chartarum* and we are calling it, in the herbarium, *Stachylidium murinotinctum* sp. nov. ad int.

Note.—In Farlow's Bibliographical Index to North American Fungi, vol. 1, part 1, p. 214 *Amphisphaeria caryophaga* Cooke is given as a synonym of *Melanomma caryophaga,* and on page 218, loc. cit. *Amphisphaeria putaminum* Cke is listed as a syn. of *Caryospora putaminum* Schw. We have not been able to see Cooke's paper. *Sphaeria druparum* Schw. on black walnuts is doubtful.

102. **Bertia fructicola** P. Henn. Reported by Prof. A. P. Morgan in Journal of Mycology, 10: 226, as found at Preston, Ohio, growing on old nuts of *Juglans regia.* We have not seen Morgan's specimens and have no personal knowledge of Henning's species. Therefore we can not say whether any of the *Didymellas* or *Melanopsammas* described in this paper are the same or not. Cfr. loc. cit. for Morgan's description.

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In addition to the usual works on systematic mycology the following special articles were consulted:

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2. Spooner. Bull. Ga. St. Bd. Entom., loc. cit. p. 39.
3. Talbot, F. B. Asthma in children II, Boston Med. & Surg. Journal, 125–126, p. 191, 1915.
4. Spencer, E. R. Abstracts of papers presented at the 11th annual meeting of Amer. Phytopath. Soc. at St. Louis, Phytopathology, Vol. 10, No. 1, p. 61.
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INDEX TO GENERA AND SPECIES.

(The numbers refer to the preceding description)

Index to Families.

Host Index.

Explanation of Plates.

PLATE 15.

Fig. 1. *Aposphaeria nucicola* E. & E., spores.
Fig. 2. *Aposphaeria allantella* Sacc., spores.
Fig. 3. *Rhabdospora baculum* Grove, spores.
Fig. 4. *Macrophoma Fitzpatriciana,* spores.
Fig. 5. *Rhabdospora baculum nucimaculans,* spores.
Fig. 6. *Phoma exocarpina* Peck, spores.
Fig. 7. *Pyrenochaeta nucinata;* a, spores; b, pycnidial bristles.
Fig. 8. *Sphaeropsis pericarpii* (Schw.) E. & E., spores.
Fig. 9. *Dothiorella nucis,* spores.
Fig. 10. *Vermicularia Dematium,* spores.
Fig. 11. *Diplodina epicarya,* spores.
Fig. 12. *Stagonospora nuciseda,* spores.

PLATE 16.

Fig. 1. *Hendersonia pustulata* E. & E., spores.
Fig. 2. *Discosia artocreas* (Tode) Fr., spores.
Fig. 3. *Volutella caryogena;* a, sporodochium; b, spores; c, tips of two setae.
Fig. 4. *Pestalozzia nucicola,* E. & E., spores.
Fig. 5. *Pestalozzia nuciseda,* spores, two of them attached to sporophores or pedicels.
Fig. 6. *Sphaeropsis pallidula,* spores.
Fig. 7. *Coniosporium nucifoedum,* a group of spores.
Fig. 8. *Helminthosporium rhopaloides,* spores.
Fig. 9. *Septocylindrium nuculinum,* spores.
Fig. 10. *Helminthosporium*-like fungus associated with *Septocylindrium.*
Fig. 11. *Sarcinella heterospora* Sacc.; a, hypha and spores; b, spores.

PLATE 17.

Fig. 1. *Schizocapnodium sarcinellum;* a, spores; b, a 4-spored ascus and spores.
Fig. 2. *Didymosphaeria nuciseda,* spores.
Fig. 3. *Amphisphaeria nucidoma,* spores.
Fig. 4. *Rhyncostoma nucis,* spores.
Fig. 5. *Leptosphaeria exocarpogena,* spores.
Fig. 6. *Leptosphaeria Lyndonvillae,* spores.
Fig. 7. *Leptosphaeria cacuminispora,* spores.
Fig. 8. *Rhynchosphaeria nucicola,* spores; a, on hickory nut; b, on beech-nut; c, a rostrate perithecium not drawn to scale.
Fig. 9. *Zignoella nucivora,* spores.
Fig. 10. *Melanomma caryophaga,* spores; a, from Kittery Point, Me. specimen; b, from Mt. Morris, N. Y. specimen.
Fig. 11. *Melanomma nuclearium* from Erb. Critt. Ital., spores.
Fig. 12. *Stagonospora nucicidia,* spores.

PLATE 18.

Fig. 1. Shuck of hickory nut with perithecia of *Leptosphaeria exocarpogena.*

Fig. 2. *Teichospora nucis* E. & E., spores.

Fig. 3. *Glonium caryigenum* E. & E., spores.

Fig. 4. Perithecia of *Melanomma caryophaga* on hickory nut from Mt. Morris, N. Y.

Fig. 5. Perithecia of *Melanomma nuclearium* on olive pit from Erb. Critt. Ital.

Fig. 6. *Didymella nucis-hicoriae;* a, an ascus and paraphysis; b, spores.

Fig. 7. *Karschia elaeospora,* spores.

Fig. 8. A portion of a hickory nut with *Phialea fructigena.* In this plate figures 1, 4, 5, and 8 are not drawn to scale.

PLATE 19.

Fig. 1. *Caryospora minor* Peck; a, usual type of spore; b and c, spore forms sometimes seen.

Fig. 2. An ascus of *Caryospora minor,* not drawn to the same scale as the spores.

Fig. 3. *Caryospora putaminum* (Schw.) De Not., spore.

Fig. 4. *Melanopsamma subrhombispora,* ascus and spores.

Fig. 5. *Monosporium avellaneum,* conidiophores.

Fig. 6. Spores of *Monosporium avellaneum.*

Fig. 7. *Fusella olivacea* (Corda), spores.

Fig. 8. A part of a beechnut with spore heaps of *Fusella.*

Fig. 9. Spores of *Sporormia* sp. on hickory nuts.

PLATE 20.

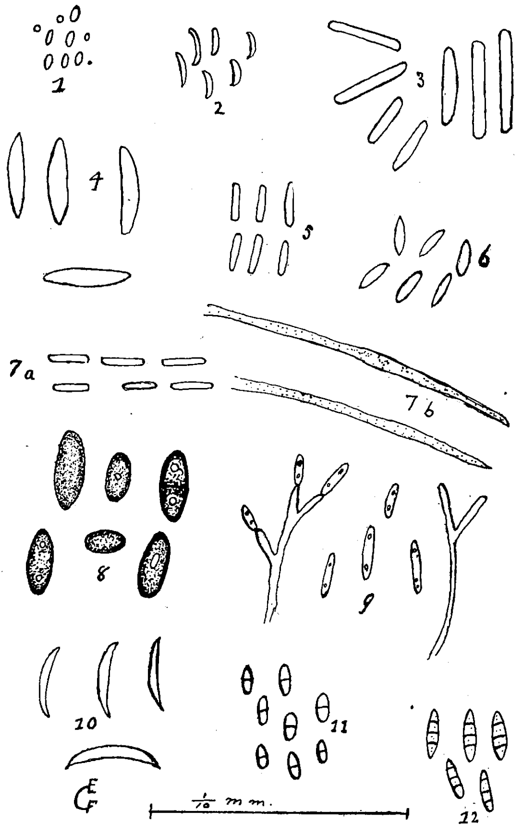
Photographed by Irving E. Sill, Lyndonville, N. Y.

Fig. 1. *Xylaria carpophila* on a hickory nut, collected by S. H. Burnham in N. Y. State. Comm. C. G. Lloyd.

Fig. 2. *Isaria* stage of *Xylaria carpophila,* specimen collected at Lyndonville, N. Y. a, the apex; b, the base.

Fig. 3. *Caryospora minor* Peck. From the type specimen on hickory nut, collected by Dr. C. H. Peck.

Fig. 4. *Caryospora putaminum* on hickory nut, collected by Mr. J. S. Moore at Starksville, Miss.



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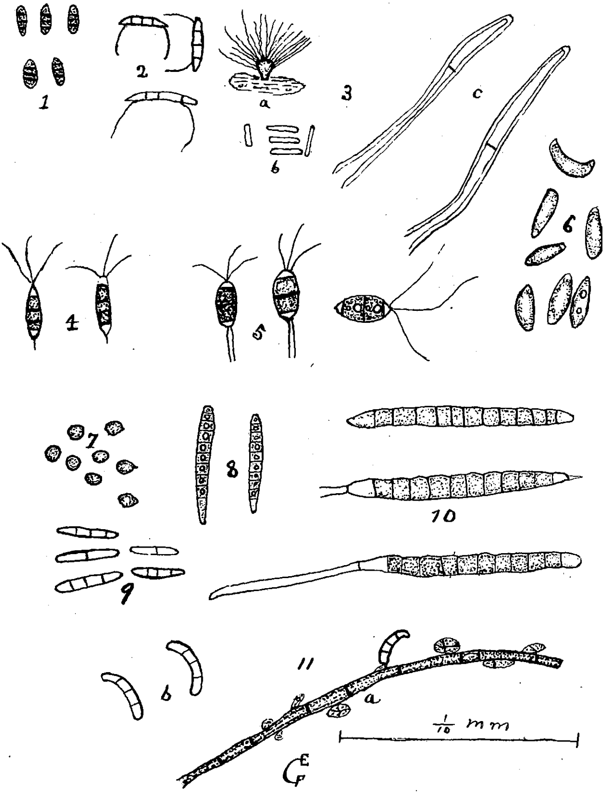

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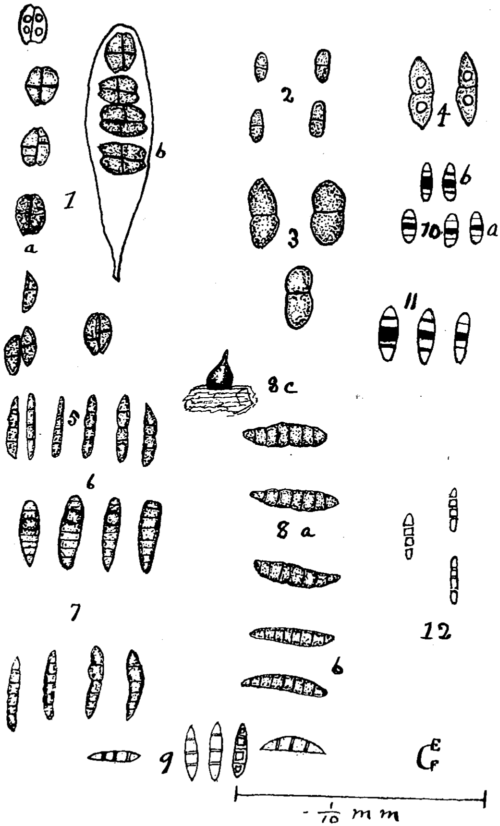

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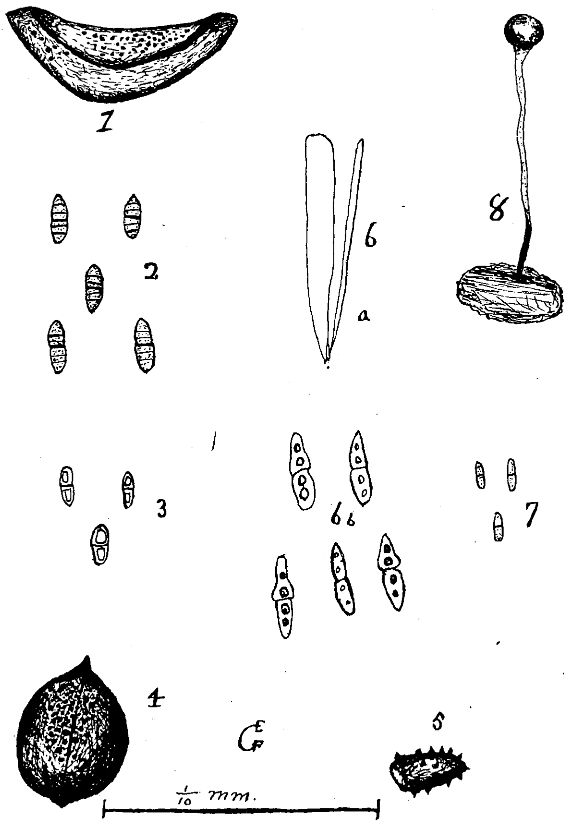

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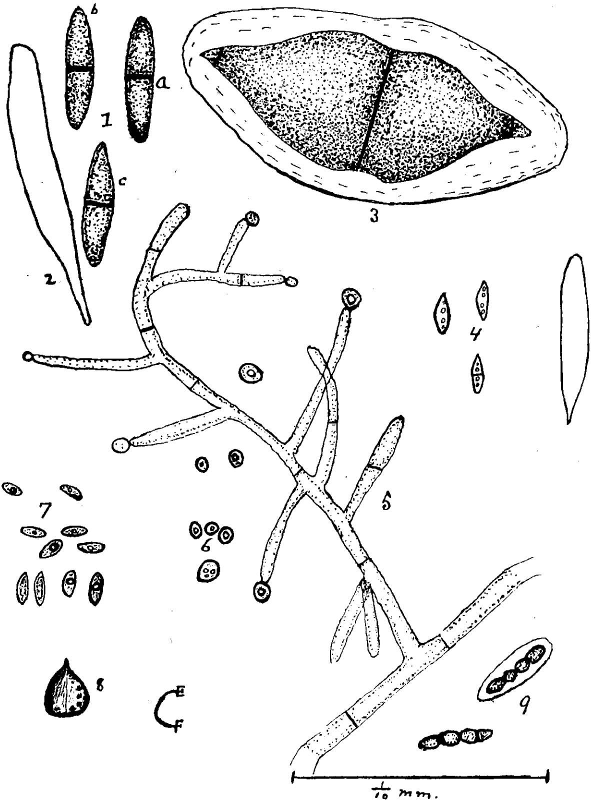

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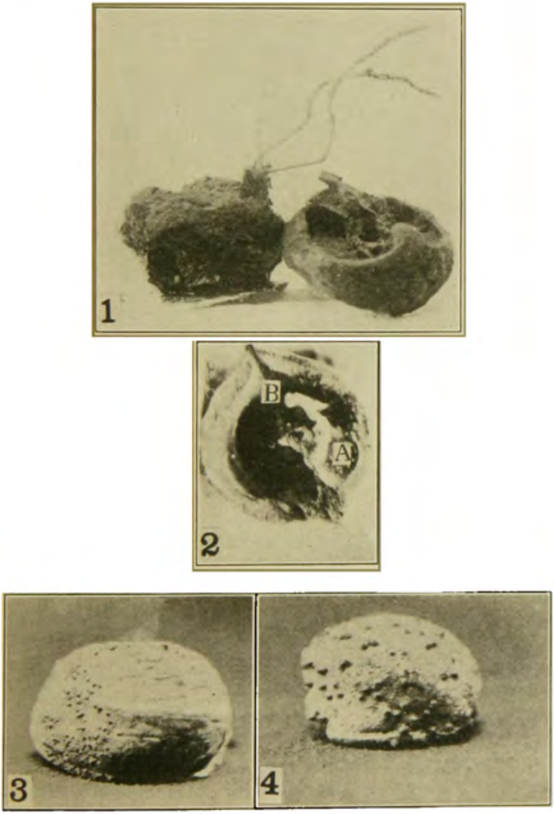

Fairman — NUT FUNGI

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
VOL. 6, PP. 117-139 APRIL, 1922

NEW OR RARE FUNGI FROM VARIOUS LOCALITIES.

BY CHARLES EDWARD FAIRMAN.

CONTENTS.

INTRODUCTION.

About forty years ago the author undertook the study of Mycology. Having some unemployed time on his hands, as a young practitioner of medicine, he was induced to do this after reading Cooke's advice, in Fungi, vol. XV, International Scientific Series, 1883, p. 294, where he says: "In conclusion, we may urge upon all those who have followed us thus far to adopt this branch of botany as their specialty. Hitherto it has been very much neglected, and a wide field is open for investigation and research. The life-history of the majority of species has still to be read, and the prospects of new discoveries for the industrious and persevering student are great. All who have as yet devoted themselves with assiduity have been in this manner rewarded. The objects are easily obtainable, and there is a constantly increasing infatuation in the study." After the lapse of many years the author is convinced that Cooke spoke true words, words which are just as true at the present time as when first written. In order to record some of his observations the author has published articles, a list of which can be found in the attached list of writings. The present paper is in continuation of these studies, and as a majority of the species mentioned were found in Western New York, publication was fittingly assumed by the Rochester Academy of Science. Some of the hyphomycetous forms were submitted to the inspection of Miss Annie Lorrain Smith of the British Museum of Natural History, but the author, alone, is responsible for the descriptions.

New Species, Series I.

DEUTEROMYCETES.

1. **Phomopsis rubiseda** sp. nov.

Pycnidia scattered, immersed becoming erumpent and protruding through pustular elevations of the epidermis, globose, black, 300 μ in diam.; spores fusoid, continuous, at times guttulate, hyaline, 10–12 x 2–2.5 μ, borne on hyaline sporophores which are 17–20 μ long.

On dead branches of *Rubacer odoratum* (L.) Rydb., Lyndonville, N. Y., June 10, 1918, C. E. Fairman. Spores narrower than those of *P insignis*. It may be an imperfect stage of *Diaporthe obscura* (Pk.) Sacc. Mr. Roy Latham sends a *Phomopsis* from Orient, N. Y., no. 425 collected on *Rubus phoenicolasius* Maxim, Apr. 18, 1915, which has pycnidia 65–100 μ in diam. and spores 9–12 x .05–1 μ borne on slender hamate sporophores 20–24 μ long. On March 16, 1916 Mr. Latham collected his no. 811 at Orient, N. Y. on *Rubus procumbens* Muhl. which proves to be another *Phomopsis* with fusoid, guttulate, hyaline spores 6–7 x 1.5–2 μ which seems referable to *Phomopsis vepris* (Nitschke) Trav. but the Orient specimens have smaller pycnidia and more slender spores. Cultural studies are needed to clear up the variability in the species of *Phomopsis on Rosaceae.*

2. **Phomopsis fraterna** sp. nov.

Pycnidia numerous, clustered on more or less discolored areas, immersed then erumpent and elevating the epidermis in a pustuliform manner, black, minute; spores fusoid, acute at ends, granular, 2-guttulate, hyaline, 10–17.5 x 3–3.5 μ, borne on long, stout, hyaline sporophores.

On branchlets of *Quercus rubra* L., Lyndonville, N. Y., June, 1918, C. E. Fairman. Host det. by W. E. Safford, Acting Botanist, U. S. Agric. Department.

3. **Phomopsis Trollii** sp. nov.

Pycnidia thickly scattered, immersed then erumpent, globose, black, minute; spores fusoid, biguttulate, hyaline, 7–9 x 3μ, on long sporophores.

On *Trollius* sp., Lyndonville, N. Y., Nov. 2, 1917, C. E. Fairman.

4. **Dendrophoma nigrescens** sp. nov.

Pycnidia thickly scattered over the blackened surface of the decorticated wood or in recesses thereof, erumpent superficial, globose, black, 80–250 and upwards in diam.; sporophores much branched, dendroid, fasciculate-ramose or even subverticillate, the ultimate branches usually exceeding 20 μ in length; spores numerous, ellipsoid or fusoid, hyaline, 2–3 x 0.5–1 μ.

On decorticated surfaces of branches of *Ilex bronxensis* Britt. Lyndonville, N. Y., June, 1918. Host det. by Dr. N. L. Britton. The same thing occurs also on branches of dead *Rhus glabra* L., L., Lyndonville, N. Y., June, 1918, C. E. Fairman.

This should not be confused with the various species of Phoma which have been listed on Ilex. *Phoma ilicicola* (C. & E.) Sacc has spores 10–12 x 6–7 μ, *Phoma ilicella* Sacc. & Penz. 20–26 x 6–7 μ, *Phoma Ilicis* Desm with spores 12–15 X 3 and the var. *Ilicis opacae* found in Carolina by Ravenel affords spores 18 x 2.5 μ.

5. **Sphaeronema epicaulon** sp. nov.

Pycnidia superficial, running in parallel lines in the depressions between the longitudinal ridges of the stems, 330–500 μ in diam., globose depressed, often collapsing, minutely rostellate, the rostrum often becoming deciduous and inconspicuous and the pycnidia subperforate, dull black, shining at the apex; spores oblong, rounded at the ends, with a small shining oil drop in each extremity, hyaline or greenish hyaline, 7–13 x 6 μ; basidia very short.

On old stems of hollyhock, *Althaea rosea,* Lake Ontario Shore Road, Lyndonville, N. Y., Oct. 1917, C. E. Fairman. Differs from *S. minutulum* D. Sacc. and *S. herbarum* Ferr. in larger guttulate spores and manner of growth.

6. **Cytospora Nyssae** sp. nov.

Stromata immersed then pustuliform—erumpent, radiate-pluri-locular, 750 μ and upwards in diam.; loculi immersed in the stroma, averaging 100 μ high and 250 μ in breadth; spores allantoid, hyaline, 6–7 x 1–1.5 μ, developed on moderately long sporophores.

On branches of *Nyssa sylvatica* Marsh, Lyndonville, N. Y., June, 1918, C. E. Fairman.

7. **Sphaeropsis subconfluens** sp. nov.

Pycnidia very thickly scattered over the surface of small branches of the host, globose or globose-depressed, opening by a central, rounded pore, the pore surrounded by a wide zone of dark colored cells, brown or black, 100–200 μ in diam; spores rounded or ellipsoid, continuous, brown, 17.5–27 x 10–17.5 μ; basidia not clearly made out but apparently short, stout and hyaline.

On dead branches of *Akebia quinata,* Lyndonville, N. Y., Apr. 1916, C. E. Fairman.

8. **Sphaeropsis Opuntiae** sp. nov.

Pycnidia thickly scattered over whitened areas, globose, immersed then erumpent, often protruding through or surrounded by thin white scales of the loosened epidermis, black, minute; spores oblong or ellipsoid, simple, continuous, hyaline at first becoming brown, 20–27 x 10–13.3 μ and probably borne on stout basidia.

On *Opuntia Opuntia,* Orient, N. Y., June 1919, Roy Latham, no. 1807 in part.

9. **Coniothyrium praeclarum** sp. nov.

Pycnidia immersed then erumpent, elevating the epidermis in a pustuliform manner, the apex of the pustule becoming dehiscent and the erupting fungus appearing subsuperficial, scattered, globose depressed, black, about 500 μ in diam.; spores very numerous, narrowly ellipsoid, hyaline at first becoming bright copper brown to pale brown, prominently 1–3 guttulate, or ocellate-guttulate, about 10–17 x 4–6 μ.

On small dead stems (of grass or at times, probably, of grape vine tendrils) twining around stems of *Equisetum,* North Ridgeway, N. Y., Oct. 1917, C. E. Fairman. Owing, probably to a difference in color and consistency, the guttae stand out prominently and this feature together with the bright coppery color of the fresh spores makes our species a beautiful Coniothyrium.

10. **Ascochyta Tecomae** Sacc. Sacc. Syll. 2:38 and 3:395.

As this is not noted in the North American Ascochytae of Dr. J. J. Davis, a description of the species as it occurs with us is appended.

Pycnidia scattered, on more or less whitened areas of the bark, at first covered by a thin epidermal layer, then becoming superficial, finally more or less exposed by the scaling off of the bark epidermis, readily detachable and then leaving a narrow brown ring of stained tissue, globose depressed, with a minute central ostiolum, composed of thin walled, delicate cells, brown or blackish, 100–150 μ in diam.; spores numerous, oblong, rounded at the ends, uniseptate at first, slightly constricted at the septum, granular or nucleolate, greenish hyaline, 6–10 x 3–4 μ.; basidia not seen.

On dead branchlets of *Tecoma radicans* (L.) D. C., Millers, N. Y., March 24, 1918, C. E. Fairman. With age the larger spores sometimes become 2-septate and the species approaches *Stagonos-*

poropsis. Cfr. Diedicke, Die Abteilung Hyalodidymae der Sphaerioideen in Ann. Mycol. 10: 142.

11. **Didymochaeta columbiana** sp. nov.

Pycnidia scattered on blackened areas at the base of the stems, immersed becoming erumpent and subsuperficial, finally more or less exposed by the falling away of the external cortical layers, globose or globose depressed, opening by a central pore 7 μ in diam., markedly setulose, brown or black, about 200–220 μ in diam.; pycnidial setae numerous, rigid, irregular to subnodulose at the sides, straight or slightly curved, brown, subhyaline toward the obtusely rounded tips, 50–100 μ in height, 3–4 μ in width; basidia not seen; spores numerous, oblong ellipsoid, rounded at the ends, uniseptate, not noticeably constricted at the septum, hyaline or subhyaline, yellowish when massed, 10–14 x 3.5–4.5 μ.

On old overwintered stems of *Chenopodium vulvaria* L., May 22, 1918, Lyndonville, N. Y., C. E. Fairman. Host det. by Paul C. Standley. The host is an adventive and has not before been listed from this locality. The spores of *Didymochaeta Americana* Sacc. & Ellis are said to be broadly constricted and narrowed in the middle.

12. **Microdiplodia ilicigena** sp. nov.

Pycnidia gregarious, immersed in the bark, finally erumpent through the elevated surface, globose, black, 400–500 μ in diam.; spores ellipsoid, rounded at the ends, uniseptate, slightly constricted at the septum, brown, 6–9 x 3.33–4 μ; basidia inconspicuous.

On small branches of *Ilex bronxensis* Britton, Lyndonville, N. Y., May 1918, C. E. Fairman.

Diplodia ilicicola Desm. has spores 20–25 x 9–10 μ and *Diplodia Ilicis Fr.* (D. *aquifolii* West.) has spores 20–24 x 12–14 μ.

13. **Diplodia thuyana** P. & C. ?

On cultivated *Retinospora,* Lyndonville, N. Y., June, 1918, C. E. Fairman.

The following characteristics were noted: pycnidia globose, or 2–3 aggregated in a white stroma, 500 μ in diam.; spores carried on stout, short, club shaped basidia, ellipsoid or obovate, 1-septate, constricted at the septum, brown, 20–25 x 10–14 μ. Socia Cytispora with allantoid, hyaline spores, 7–9 x 1 μ.

Diplodia thuyana P. & C. is described as having spores 16–23 μ long. Saccardo notes a form found in Italy which he calls var. *B Thuyae orientalis* and considers *D. Thuyae* Sacc. in Mich. (nec West.) a synonym. This has the pycnidia gregarious or subaggregated with spores 20–25 x 10 μ. *Diplodia Thuyae* West. is in-sufficiently described. *Diplodia Otthiana* Sacc. & Syd. is a name given in the Sylloge to *D. Thuyae* Otth., and is said to afford spores 20 x 9 μ and no pycnidial stroma. The Lyndonville specimens on *Retinospora* seem referable to *Botryodiplodia* but in the face of so many Diplodiae noted above we are unwilling to call it a new species.

14. **Stagonospora nyssaecola** sp. nov.

Pycnidia immersed, becoming erumpent through the epidermis which is variously lacerated, rounded, elongated or irregular in shape, externally black, contents white or greenish yellow, 500–1000 μ in diam; spores fusoid, at times soleiform, straight or variously curved, often inequilateral, acute or subacute at the ends, 1–3 septate, not markedly constricted, hyaline at first becoming greenish or pale yellow, sometimes granular or guttulate, 17–25 x 5–7 μ, borne on stout hyaline sporophores 10–20 μ long.

On small branches of *Nyssa sylvatica* Marsh, Lyndonville, N. Y., June, 1918, C. E. Fairman.

15. **Hendersonia Arundinariae** sp. nov.

Pycnidia thickly scattered erumpent superficial, globose or globose depressed, 150 μ high, 250 μ broad, black; spores numerous, oblong cylindric, straight or surved, ends obtusely rounded, at times attenuated and subtruncate, 3-septate, not constricted, guttulate, brown, 10–17.5 x 6–7 μ; basidia stout, short, hyaline about as broad as the spores.

On a fragment of an old cane fishpole, *Arundinaria macrosperma* Michx., lying on the ground, Lyndonville, N. Y., May, 1916, C. E. Fairman.

16. **Rhabdospora ilicigena** sp. nov.

Pycnidia scattered or gregarious, erumpent superficial, globose or globose depressed, often flattened at the apices, black, 200–300 μ in diam.; spores numerous, filiform, fusoid elongate, curved or crescentic, with numerous uniseriate guttulae, hyaline, 30–40 x 3–.5 μ, sessile or on very short basidia which are intricately interwoven at base into a dark brown subbasidial layer, slightly spreading at the sporiferous apices.

On small branches of *Ilex bronxensis* Britton, Lyndonville, N. Y., June, 1918, C. E. Fairman.

17. **Rhabdospora cryptosporopsis** sp. nov.

Pycnidia gregariously nestling beneath the pustuliform-raised epidermis, subglobose, black, minute; spores straight, at times curved, subarcuate or bent at one extremity, 17–35 x 0.5–1 μ, apparently borne on hyaline sporophores.

On a fallen branch of Platanus, Ridgeway Corners, N. Y., March, 1918, C. E. Fairman. This has the spores of a Rhabdospora, but the ill defined pycnidia approach Cryptosporium.

Gamonaemella gen. nov.

Pycnidia separate, superficial, globose or globose-conoid, sub-carbonaceous, minute, black, destitute of hairs or setae; spores hyaline, filiform or elongated bacillar, multiguttulate, becoming multilocular, connate, multiradiate and stellate in fascicles of 3–5 or upward.

18. **Gamonaemella divergens** sp. nov.

Pycnidia scattered or gregarious, adnate-superficial or with the base slightly sunk in the matrix, globose or globose-conoid, with minute central papilliform ostiola, subrugose, black, 300–500 μ in diam.; spores filiform or elongated bacillar, subacute at the apices, 3 to several stellate-radiate, connate, multiguttulate, becoming multilocular, hyaline or subhyaline, 60–150 μ between the distal extremities, with the single arms or radii averaging 30–80 μ in length 1.5–2.5 μ in width.

On a fragment of an old cane fish pole lying on the ground, *Arundinaria macrosperma* Michx., Lyndonville, N. Y., May 15, 1916, C. E. Fairman. No difference in the structure of any of the radiating arms could be discerned, but the lowest one may be the basidium. The arms seem to be folded down along the sides of the basidium and to expand and spread outside the pycnidia. *Gamonaemella* may be differentiated from *Gamospora* by not having hairy pycnidia, and from *Eriospora* and *Gamosporella* in not having the pycnidia in a stroma. With the latter three genera it seems worthy of being placed in a special new section *Gamoscoleciae,* belonging to the scolecosporous *Sphaeropsideae.*

19. **Leptostroma Mitchellae** sp. nov.

Pycnidia gregarious or scattered, membranaceous, of loose cellular structure, subdimidiate, translucent when young, elongate, lengthwise cleft, often incomplete, multilacerate or cracked on top, brown or black, 100–175 μ in length; basidia stout, cylindric, often with uneven or irregularly contracted walls, slightly dilated at the base, 1–2 μ in width and from two to three times as long as the spores; spores cylindric, rounded at the ends, simple, continuous, hyaline, 7–10 x 1.5–2 μ.

On dead stems of *Mitchella repens* L., Orient, N. Y., May, 1916, Roy Latham.

20. **Heteropatella acerina** sp. nov.

Pycnidia gregarious, at first spherical, becoming widely opened and patellate, when dry irregularly contracted, 250–750 μ in diam., black; basidia simple or branched, hyaline, 17–30 x 2 μ; spores carried on the ends of the basidia, fusoid-oblong, hyaline, 5–7 x 1.5–2 μ.

On the blackened surface of a decorticated branch of *Acer*, Yates Center, Orleans County, N. Y., April, 1919, C. E. Fairman.

21. **Discella zythiacea** sp. nov.

Pycnidia scattered, erumpent or depressed-stictoid, becoming superficial, varying in diameter from a minute point up to 300 μ, globose becoming disciform, at first closed then opening and exposing a pale red to flesh colored disc of soft texture, with an irregular margin which is not markedly dentate or fimbriate, externally brown or black; spores numerous, ellipsoid, uniseptate, not constricted at the septum, rounded at the ends, hyaline, 6.66–11 x 2.5–.33 μ.; basidia not seen.

On a fallen decorticated branch of *Robinia pseudacacia*, Lyndonville, N. Y., March, 1919, C. E. Fairman.

22. **Didymosporium propolidioides** sp. nov.

Acervuli scattered on whitened areas of the decorticated wood, suberumpent, punctiform at first becoming hysteriiform-elongated, finally more or less open, running parallel with the wood fibres, black, 250–1000 μ in length; spores numerous, ellipsoid, often irregular, uniseptate, constricted at the septum, brown, 6–7 x 3.5 μ.

On old decorticated cedar (*Juniperus*) stump, Orient, N. Y., Mat. 1917, Roy Latham no. 852.

Basidia were not seen. The spores become at times 2-septate. I am indebted to Prof. Dearness for the suggestion that this might be a *Didymosporium*. It may be said to occupy ground between the *Dematiaceae* and *Melanconiaceae*.

23. **Scolecosporium transversum** sp. nov.

Acervuli at first immerse and pustuliform, becoming transversely erumpent, finally embraced by the ruptured and elevated epidermis which splits longitudinally, black, 500–1250 μ in length; spores oblong-fusoid, rounded at one end, hyaline, apiculate at the other, 3–5-septate, not markedly constricted, inner cells brown, end cells hyaline or subhyaline, 20–30 x 10 μ borne on the ends of long simple or branched, hyaline, thickly interwoven sporophores which are from 30–75 μ long.

On bark of the root of a pear tree, Lyndonville, N. Y., March, 1918, C. E. Fairman.

24. **Graphium sordidiceps** sp. nov.

Synnemata gregarious or scattered, erect, subvillose, firm, monocephalous, 650–1000 μ in height; stipe white, cylindric, arising from a round white base which persists after the falling away of the stipe, dilated at the base, tapering gradually upwards to the capitulum, 350 μ wide at the base, formed of interwoven, difficultly separable, hyaline, septate hyphae which are about 3.5–4 μ in width, bearing at the apex a globose, olivaceous, dirty brown or sordid capitulum; capitulum about 300 μ high and 280 μ wide; spores obovate to flask-shaped, hyaline, 7–8 x 3.5–4 μ.

At the junction of the trunk and root of a shrub of *Lonicera* growing on the bank of Johnson Creek, Lyndonville, N. Y., June 16, 1918, Fairman, Wright and Gray.

The earth had to be removed to secure the fungus. Probably comes near to *Graphium pruinosipes* (Peck) Sacc. but no spore measurements are given in the original description in Rep. N. Y. State Mus. p. 28. Our species seems distinct in its differently shaped, and probably larger spores.

ASCOMYCETES.

25. **Anthostomella endoxyloides** sp. nov.

Perithecia sunken in the wood, overlaid by a black, discolored, clypeiform surface, globose, with thick, Massaria-like walls, 300–500 μ in diameter, averaging about 350 μ; asci cylindric, sessile or short stipitate, 6–8 spored, 83–127 x 10–12 μ, paraphysate; sporidia irregularly biseriate, often uniseriate above and below and biseriate in the middle, narrow ellipsoid or fusoid, straight or curved, often inequilateral, granular, frequently with a small gutta in each end, brown, lighter in color at the ends, 20–27 x 6–7 μ.

On a dead tree of some species of *Populus,* Orient, N. Y., Sept., 1919, Roy Latham, no. 2073. The spores resemble in color and shape *Anthostomella calocarpa* Syd. in Baker, Fg. Malayana 503 but are twice as large and the gross appearance is also different. The perithecia when exposed by a section of the wood resemble those of *Endoxyla parallela.*

26. **Diaporthe Hamamelidis** sp. nov.

Perithecia growing under the outer bark and resting upon a thin reddish brown layer of tissue just over the wood, coalescent in groups or occuring also singly, globose conoid, with minute papilliform ostiola, dull black, about 300 μ in diam; asci clavate or cylindric, with a moderately long stipe, 8-spored, 100–125 x 10–14 μ, filiform paraphysate; sporidia fusoid, uniseptate, 4 globose-nucleate, constricted at the middle, biseriate, hyaline, 24–28 x 6–7 μ.

On dead stump of *Hamamelis virginiana,* Lyndonville, N. Y., June, 1918, C. E. Fairman. This is not well defined Diaporthe. A stroma is not evident unless the discolored surface be so considered, but the perithecia are often aggregated like Diaporthe and the spores are typical of that genus.

27. **Didymosphaeria Lonicerae riparia** var. nov.

Perithecia scattered, resting under the bark, becoming suberumpent, depressed spherical, 250 μ or more in diam., black; asci cylindric, rounded at the apex, 6–8 spored, 100–110 x 10 μ, filiform paraphysate; sporidia uniseriate, ellipsoid, obtusely rounded at the ends, uniseptate, constricted at the septum, when young with a prominent gutta in each half, brown, 14–17.5 x 6.66 μ.

On *Lonicera* sp., banks of Johnson Creek, Lyndonville, N. Y., June 16, 1918, Fairman, Wright and Gray. From *D. albescens* Niessl (*D. brunneola* Niessl) it is distinguished by the absence of any purplish or dark covering and larger asci and sporidia. From *D. Lonicerae Sacc.* in not having subacute spores. The length of the asci of this last species as given in Sylloge Fungorum, 1;711, viz., 188 x 8 may be a mistake.

28. **Melanomma nigriseda** sp. nov.

Perithecia thickly scattered but not forming a continuous layer, at times coalescent in small groups, adnate superficial or semi-immersed, seated on the blackened and crustose surface of wood cavities, globose or subconic, 250–260 μ in diam., flattened at the base, dull black, subshining at the apex, rough, with obtuse conic ostiola which are 60–70 μ broad at the base and 50–60 μ high; asci clavate, long stipitate, 8-spored, 140–160 x 7 μ; sporidia uniseriate, fusoid oblong, mostly curved, straight at times, 3-septate, slightly constricted at the septa, hyaline at first becoming pale brown, one gutta in each cell, 17–20 x 5.5–6.6 μ.

In cavities of Beech (*Fagus*) cut for firewood, Lyndonville, N. Y., July, 1918, C. E. Fairman. *Melanomma nigricans* E. & E. Proc. Acad. Nat. Sc. Phil., 1895, p. 417 is said to have perithecia "densely crowded forming a nearly continuous layer on the surface of the blackened wood." *M. nigriseda* has the perithecia scattered, at times quite thick, but never forming a continuous layer, and also has larger perithecia, different ostiola and larger asci. It may also be mentioned that the sporidia of *M. nigriseda* have end cells equal and each cell is 1-guttulate. The author has examined the structure of *M. nigricans* at the New York Botanical Garden.

29. **Leptosphaeria lyciophila** sp. nov.

Perithecia globose depressed, erumpent superficial, brown, 200–400 μ in diam.; asci clavate or cylindric, rounded at the apex, long stipitate, 8-spored, 65–85 x 7 μ, filiform paraphysate; sporidia biseriate, clavate, obtusely rounded at one end, attenuated and acute at the other, 3–4-septate, not constricted, hyaline at first, becoming greenish-hyaline then yellow, straight or more or less bent at the smaller attenuated end, 27–30 x 3–3.5 μ.

On dead stems of *Lycium vulgare* (Ait. f.) Dunal, Yates, Orleans County, N. Y., May, 1918, C. E. Fairman.

Leptosphaeria Lycii Pass. is said to have spores 12.5 x 5 and can not be this species. The clavate or rhopaloid spores of *L. lyciophila* should distinguish it readily from *Fenestella Lycii* Hazl. which sometimes appears like *Leptosphaeria* in its young stage. Apparently this species comes nearest to *Leptosphaeria sicula* Sacc. et Beltr. but differs in its unconstricted and perfectly clavate spores with fewer septa. It also differs in size of spores, and number of septa from *L. rhopaloides* Berl. and *L. helminthospora* (Ces.) DeNot.

30. **Leptosphaeria Hamamelidis** sp. nov.

Perithecia immersed, becoming erumpent superficial, gregarious or thickly scattered, globose or oblong and flattened, centrally ostiolate or papillate, of soft membranaceous texture, easily removable from the surface, but then more or less entangled with wood fibres, black when viewed with a lens, brown under the microscope, about 250 μ in diam., 100–120 μ in height; asci saccate, short stipitate, rounded at the apex, filiform paraphysate, 50 x 17.5 μ; sporidia irregularly tristichous or conglobate, rarely distichous, fusoid, 3-septate, 4-locular, the two middle loculi larger and globose, the end cells conoid, yellowish 20–24 x 6–7 μ.

On dead *Hamamelis virginiana,* Lyndonville, N. Y., July, 1918, C. E. Fairman.

31. **Leptosphaeria pseudohleria** sp. nov.

Perithecia scattered or gregarious, intermediately situated in the depressions between the longitudinal ribs of the stems, often on more or less discolored areas, erumpent becoming subsuperficial, globose depressed, opening by a minute rounded central pore, brown or black, 150–250 μ in diam.; asci ovate or saccate, sessile, rounded at the apex, straight or curved, 40–75 x 23–24 μ, sparingly surrounded by filiform paraphyses; sporidia irregularly biseriate or conglobate, oblong, 3-septate, constricted at all the septa but more deeply constricted at the middle septum, 4-celled, each cell with a large, shining, greenish when fresh, rounded oil-drop, readily separating in the middle, at least outside the asci, into two parts, one part shorter and broader, 10 x 7 μ, and the other part longer and narrower, 13.33 x 5.5–6 μ, brown or greenish brown, the complete undivided spore measuring 23.33–30 x 7 μ.

On old stems of *Typha latifolia* on the ground in a marshy place near a roadside brook, Lyndonville, N. Y., Oct. 1917, C. E. Fairman. When fresh the contents of the perithecia have a pale green tint upon crushing, the spores in the asci having also a greenish cast, and outside the asci the nuclei retain their green color. These features are not marked in the specimens which have been in the herbarium for some time. Whether the spores subdivide in the asci could not be definitely determined. The subdivision is unmistakably in spores outside the asci. Species of *Leptosphaeria* subdividing outside the asci would seem to merit a genus by themselves. The genus *Leptosphaeropsis* of Berlese would not fit our specimen without emendation. When first found the specimen was included in our herbarium under *Ohleria.*

32. **Sporormia ourasca** sp. nov.

Perithecia gregarious, thickly scattered over the blackened surface of the wood, rarely sparse, often overlaid by straw, vegetable fragments and moist earth, sometimes two or three perithecia touching and becoming subcoalescent, globose, at times collapsing, at first covered with a white tomentum, becoming bare with age, superficial and prominent, although probably immersed at first, black, 750–1000 μ in diam.; asci oblong, the upper, spore bearing portion, flask shaped or obovate, contracting rapidly to a very long pedicellate, filiform stipe which frequently ends in a bipartite basal enlargement, 6 to 8 spored, 70–130 x 13.3 μ; sporidia 2-3-seriate or conglobate, oblong, guadrilocular, three septate, end cells globose-conoid, inner cells globose, often with a light colored band across some of the cells, ranging in tint from hyaline through indigo blue or olivaceous to dark brown or even opaque, 23–30 x 6.66 μ; paraphyses acute tipped, about as long as the asci.

On the under side of a pine plank in a meadow, immersed in a mixture of straw, grass and moist earth, Gambell Farm, Lyndonville, N. Y., May 24, 1918, C. E. Fairman. Easily distinguished by its habitat, and asci which are shaped like a spermatozoon or tadpole, and the long tail-like filiform stipe. This stipe in the shortest specimens is as long as the sporiferous portion of the ascus but usually is from two to two and one half times as long. This was made out, to avoid error, by Griffith's method, the use of Iodine solution. Said application of Iodine shows the sporidiogenic layer extending from the head of the ascus downwards into the prolonged stipe, showing the stipe to be a real stipe and not a stretched out fragment of the mucous coat. Furthermore the application of Iodine shows that the matured spores, at least when free from the asci, color blue throughout, or that the majority do, also that the paraphyses and mixed tissue around the asci stain a yellowish brown, while the sporidiogenic layer in the asci stains a darker brown, especially when viewed immediately after the application, with blue glass in the substage of the microscope. The spores themselves seem to afford no features different from several previously described species of Sporormia. They are surrounded by a mucous zone, sometimes guttulate, the middle cells sometimes seem to overlap or to be obliquely connected. The perithecia may crack and fall away, leaving a base which is white from the probable remains of the contents. The wood underlying the fungi is found to be stained a reddish tint after the blackened surface is sliced off.

33. **Cucurbitaria rimulina** sp. nov.

Perithecia cespitose, erumpent through rimulae of the decorticated branches of the host, rarely more superficially seated upon brownish dematiaceous patches, sometimes sparse, black, globose, with papilliform ostiola which apparently become deciduous, and then the perithecia are preforate, about 250 μ in diam. asci 8-spored, clavate or cylindric, short stipitate, rounded at the apex, about 100 x 10 μ on an average, but very much longer ones occasionally seen, obscurely filiform paraphysate; sporidia oblong or obovate, 3-septate, constricted at the septa, one half of the spore generally larger and more rounded than the other, muriform, brown, 18 x 6.6–7 μ.

On decorticated branches of *Quercus rubra* L., Lyndonville, N. Y., April 5, 1919, C. E. Fairman.

34. **Gloniopsis Lathami** sp. nov.

Perithecia erumpent superficial, situated between the longitudinal ribs of the host stems, scattered, oblong fusoid, opening by a longitudinal cleft, black; asci clavate or cylindric, 8-spored, short stipitate, rounded at the apex, surrounded by numerous filiform paraphyses, 75–80 x 10–13 μ; sporidia oblong fusoid, 3–5–septate, one or more of the larger inner cells with one or two longitudinal septa, usually not very much constricted but occasionally so at the middle septum, hyaline or greenish hyaline, often surrounded by a mucous zone, 17–20 x 6–7 μ.

On dead stems of *Helianthus giganteus,* Orient, N. Y., May 12, 1918, Roy Latham, no. 1194.

35. **Gloniopsis Lathami asymetrica** var. nov.

Perithecia erumpent superficial, fusoid oblong, black, opening by a longitudinal cleft; asci clavate cylindric, rounded at the apex, short stipitate, surrounded by numerous filiform, nucleolate paraphyses which are often globose enlarged at the apices, 8–spored, 65–85 x 14–17 μ; sporidia biseriate, ellipsoid, 3–5 septate, constricted at the middle, obtusely rounded at the ends, one half larger and more obtuse, at first cribrose-guttulate, becoming muriform, hyaline, 17–20 x 7–10 μ.

On dead stems of *Lilium canadense,* Orient, N. Y., May 12, 1918, Roy Latham. Comes near *Gloniopsis culmifraga* (Speg.) Sacc. but asci and spores are larger, and no mention is made of the inequality of the sporidia in the description.

Species of Rare Occurrence or Otherwise Noteworthy.

36. **Lophiostoma excipuliforme** (Fr.) Ces. et DeNot.

The typical form was found on the bark of exposed roots of Acer, Lyndonville, N. Y., June 1908, C. E. Fairman. Ellis and Everhart in North Amer. Pyrenomycetes, p. 222 report the "we have seen no American specimens of the normal form, on bark of deciduous trees." Reported also by Prof. Dearness in Mycologia, 9:350 on maple bark, collected by S. H. Burnham at Hudson Falls, N. Y.

37. **Dinemasporium decipiens** (De Not.) Sacc. var. **Citri C.** Mass.

Fine specimens were found on a decorticated place on a living cultivated orange tree, Lyndonville, N. Y., Sept. 1917, Fairman.

38. **Zignoella macrospora** Sacc.

On a decorticated, fallen branch (probably of some species of Fagus) Lyndonville, N. Y., Oct. 1915, Fairman.

39. **Leptosphaeria Equiseti** Karst.

On dead stems of *Equisetum,* North Ridgeway, N. Y., Oct. 2, 1917, Fairman.

40. **Leptosphaeria Ailanthi** Karst. et Har.

On decorticated wood of *Ailanthus,* Lyndonville, N. Y., Apr. 1916, Fairman. Sec. Berlese, Icones Fungorum 1:58 this is *Leptosphaeria eustoma Ailanthi* Berl.

41. **Phomopsis Ailanthi** (Sacc.) Diedicke.

On Ailanthus, Lyndonville, N. Y., Oct. 1917, Fairman.

42. **Patellaria triseptata** (Karst.) Sacc.

On fallen branches of shrubbery, *Rosa* and *Lonicera* mixed, Lyndonville, N. Y., Oct. 1917, C. E. Fairman.

New Species, Series II.

Since the above descriptions were written the following additional species have been found.

43. **Clasterosporium larviforme** sp. nov.

Tufts indeterminately effused, forming a densely felted, velvety or fluffy, readily separable layer on the surface of bare wood, deep black; hyphae straight, rarely curved, septate, smooth or at times echinulate roughened, even, brown, attaining a length of 500 μ or upwards; spores variable in shape, oblong, ellipsoid, obovate to sigmoid incurved or ampulliform, 1 to 2 septate when young, becoming multiseptate (usually ranging from 6 to 12 septate), constricted at the septa, densely verrucose and hairy, brown to black, lighter at the ends, 20 x 10 μ when young, reaching at maturity dimensions of 40–110 x 14–17 μ, subsessile on the hyphae or borne on short, globose pseudosporophores, mostly pleurogenous, at times acrogenous; sporophores sometimes detached with the spores causing them to appear hyaline subpedicellate. Plate 22, figs. 1–5.

On the cut surface of old firewood, Lyndonville, N. Y., summer of 1920, Charles E. Fairman. This species seems to combine characters of *Heterosporium* and *Clasterosporium*. Specimens were submitted to Miss Annie Lorrain Smith of the British Museum who advised that it be included in *Clasterosporium*. The spores resemble in mode of origin those of *Clasterosporium cornutun* E. & E. which, according to the description in West Va. Geological Survey, Vol. V (A) p. 37, are said to appear "at first as a simple nodule or tubercle on the side of the thread." Under low powers of the microscope our species resembles a mass of larvae feeding on vegetable debris.

44. **Hendersonia foliorum hamamelidina** var. nov.

Leaf spots round, pale in the center, surrounded by a brown border, becoming deciduous; pycnidia globose or globose depressed, erumpent, black, up to 200 μ in diam.; spores fusoid or ellipsoid, attenuated at the ends, 2–4 septate, not constricted, subhyaline to very pale brown, lower cell persistently hyaline, inequilateral, straight or curved, 14–20 x 6–7 μ.

On leaves of *Hamamelis,* Burma Woods, Town of Barre, Orleans Co., N. Y., Oct. 7, 1920, Charles E. Fairman. This approaches *Stagonospora* but because the spores show color, though faint, it is placed in *Hendersonia*.

45. **Cladosporium punctulatum xylogenum** var. nov.

Hyphae long, flexuose, septate, often containing a series of globose oil drops, 5–7 μ in width; spores ellipsoid, 1–3 septate, brown, minutely punctulate roughened, 10–20 x 7–8 μ.

On the outside of a cigar box exposed to damp weather, Lyndonville, N. Y., Dec. 14, 1920, C. E. Fairman. Associated with

Epicoccum agyrioides Cda. *Cladosporium punctulatum* S. & E. has heretofore been found only on leaves.

Amblyosporiopsis gen. nov.

Sterile hyphae repent, simple or branching, septate; conidiophores erect, simple or branching, hyaline, dilated at the apices into subglobose, often facetted heads; conidia usually formed on the primary heads, occasionally on secondary or proliferate ones, (originating from minute sterigmata?), globose or ellipsoid at first, becoming subcuneate, bullet or shell shaped, truncate at the upper end, hyaline.

46. **Amblyosporiopsis parasphenoides** sp. nov.

Tufts effused, tawny or sublateritious; conidiophores simple or branched, hyaline, septate, averaging 13.5 μ in width, dilated at the apices into subglobose heads averaging about 24 μ in diam.; conidia when mature subcuneate or bullet shaped, truncate at the upper end, hyaline, 10–18 x 8–14 μ. Plate 21.

On bark of firewood, *Acer* sp., Lake Ontario Shore, Town of Yates, Orleans County, N. Y., April 28, 1920, Charles E. Fairman. The genus differs from *Amblyosporium* in having the conidiophores apically dilated into heads, and in spores truncate only at one end. The conidiophore heads are at times facetted and slightly angular at the junction of the facets. It seems as if Nature was here attempting to depart from globose conidiophore heads to those of a polyhedral type. Plate 21, fig. 1 a shows a facetted head, and fig. 2 a secondary or proliferate head sprouting up from a primary one. Spore truncation is apparently best observed in the outer and maturer spores of chains where they are least subject to pressure or crowding.

47 **Stemphylium subsphaericum** sp. nov.

Tufts effused, often overrun with white mucedinous filaments, cinereous or black; fertile hyphae repent, short, branching or anastomosing, hyaline, about 2.5 μ in width; spores acrogenous, subglobose, cruciate or sarciniform divided, constricted or indented, subhyaline at first, becoming black or opaque, 7.5–14 μ in diam. (averaging 10 μ in diam.).

On rotten wood, Palmer's Woods, Town of Ridgeway, Orleans County, N. Y., June 7, 1918, C. E. Fairman. *Stemphylium sphaericum* Sacc., according to the specimens in Baker's Fungi Malayana number 395 has round tufts or heaps and the spores are spherical, reticulately divided, almost opaque and measure 30 x 20–22 μ. The plant described above has an effused manner of growth and much smaller spores.

48. **Exosporium scolecomorphum** sp. nov.

Sporodochia flattened, pulvinate or punctiform, sometimes crowded into a more or less continuous layer, minute, black; spores ellipsoid when young, becoming cylindric or obclavate, rounded at the upper end, borne on stout, cylindric, short, straight or curved, septate, concolorous pedicels from 8 to 10 μ in length extending a variable distance above the surface of the sporodochium, straight or variously curved or bent, 2–16 (possibly 18) septate, not markedly constricted at the septa, red or vinous brown to brown, 24–75 x 10–14 μ. Plate 23, fig. 7.

On the under surface of an old rail, lying on the ground, Stroyan lane, Lyndonville, N. Y. June 16, 1918, Fairman, Wright and Gray. Mixed with the spores are numerous brown hyphae about 3.5–4 μ in width. The free spores are often without a pedicel.

Diseases of Cultivated Plants.

In a garden at Lyndonville, N. Y., two cultivated plants have been found affected by probably hitherto unreported fungus diseases. The first of these we formerly called phomose of the cinnamon vine. Later consideration, since this paper was prepared, enables us to state that it is not a true phomose but probably of saprophytic origin. The fungus found may be thus described:

49. **Phoma Dioscoreae** sp. nov.

Pycnidia thickly scattered on oblong, darkened areas of the stems, immersed then erumpent, black, 200–250 μ in diam.; spores ellipsoid, or subglobose, continuous, hyaline, 7–10 x 3.5–4 μ.

On stems of *Dioscorea batatas* Decne., cult., garden of Miss L. A. Weld, Lyndonville, N. Y., May and June, 1920, C. E. Fairman. Only by culture experiments can it be told whether this is the stem form of *Phyllosticta Dioscoreae* (Cke) Cke. or whether a distinct species is the cause of the affection. No *Phyllosticta* has been observed on the leaves of the diseased plants. *Phyllosticta Dioscoreae* (Cke) Cke may be found in Fungi Columbiani number 1445 on *Dioscorea villosa,* collected by L. W. Nuttall, at Nuttallburg, W. Va. In this the spores are rounded, irregular or ellipsoid, are not numerous and are filled with greenish hyaline granules. They measure about 7 x 4–7 μ. The pycnidia, 200 μ in diameter, are on definite spots. Ellis and Everhart in North American Phyllostictas give Cooke's spore measurements, viz., 8–10 x 3 μ. The second disease we are calling leaf spot of cultivated *Impatiens.* From early autumn until the occurrence of frost the leaves of a bed of cultivated *Impatiens* bordering the affected cinnamon vine above described were found to be spotted and diseased. Infected leaves became weakened, discolored, languid and apt to fall to the ground. Plate 23, fig. 1 shows a leaf with the disease. Several species of fungi belonging to the genera *Discosia, Pestalozzia, Macrosporium* and *Cladosporium* seem to be associated with the spots. The most abundant parasite and probable cause of the affection is a *Discosia* which has the following characteristics:

50. Leaf spots small, round, oblong, angular or irregular, brown, surrounded by a purple or reddish purple border; pycnidia irregularly scattered over the spots, globose depressed, 100–200 μ in diam., black; spores fusoid, at first continuous, becoming triseptate, not markedly constricted, armed at each end with a curving filiform bristle 6 μ or more in length, hyaline, 12–14 x 3.5 μ. Plate 23, fig. 2.

This is referred to *Discosia maculicola* Ger. Along with the *Discosia* was found a fungus with the following characters:

Pycnidia (?) globose centrally ostiolate, 130–190 μ in diam., black; spores fusoid, 3–4 septate, slightly constricted at the septa, armed at one end with 3 spreading hyaline bristles, 6–7 μ in length, at the other end provided with a short, hyaline pedicel, hyaline, 15–20 x 3.5–5 μ. Plate 23, fig. 3.

Material was not sufficient to say whether this was a *Pestalozzina,* immature *Pestalozzia* or a *Bartalinia.* A true *Pestalozzia* was also found on the leaves. Plate 23, fig. 4. In this the spores are triseptate, the two inner cells dark brown and globose, the end cells conoid, hyaline, armed at one end with 3 bristles and at the other with a long hyaline pedicel, and measured 20 x 7 μ. Plate 23, fig. 5, represents the associated *Macrosporium* and fig. 6 the *Cladosporium.*

On leaves of cultivated *Impatiens* in the garden of Miss L. A. Weld, Lyndonville, N. Y., Sept. to Nov. 1920, C. E. Fairman coll. Lyndonville, New York.

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Index to Genera and Species.

(The numbers refer to the preceding description)

Host Index.

Explanation of Plates.

Plate 21.

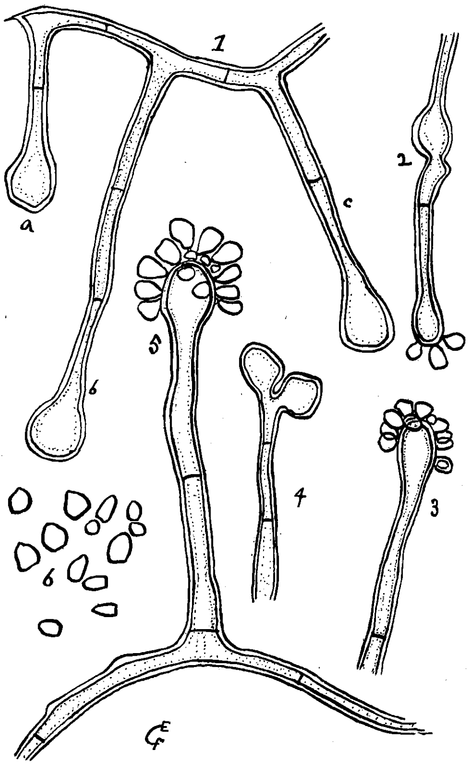
Amblyosporiopsis parasphenoides n. sp.
Fig. 1,a, a facetted head.
Fig. 1,b and c, the usual subglobose heads.
Figs. 2 and 4, irregular forms of conidiophorous heads.
Figs. 3 and 5, conidiophorous heads.
Fig. 6, a group of detached spores.

Plate 22.

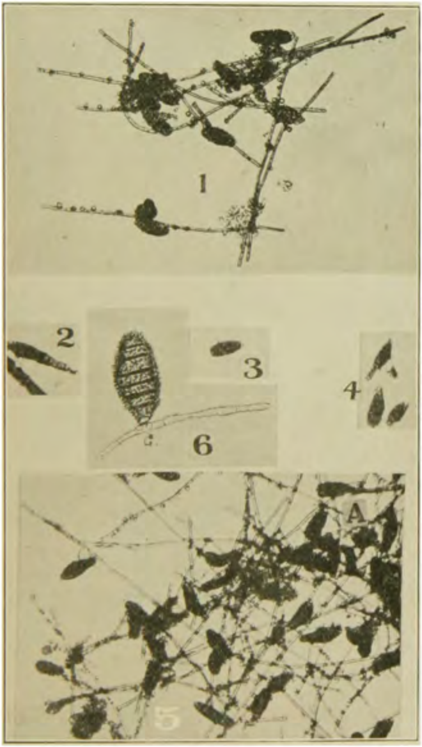
Clasterosporium larviforme sp. nov.
Fig. 1, spores and hyphae, the latter showing the globose bodies from which the spores develop.
Figs. 2, 3, 4, detached spores.
Fig. 5A, an acrogenous spore.
Fig. 6, a camera lucida sketch of a spore more highly magnified.
Figs. 1, 2, 3, 4 and 5 from microphotographs by A. Tennyson Beals, 2929 Broadway, N. Y. City.

Plate 23.

Fig. 1. Leaf of Impatiens showing leaf spot disease. From a photograph by Irving E. Sill, Lyndonville, N. Y.
Fig. 2. Spores of Discosia.
Fig. 3. Spores of (Pestalozzina?)
Fig. 4. Spores of an accompanying Pestalozzia.
Fig. 5. Spores of Macrosporium.
Fig. 6. Hypha and spores of Cladosporium.
Fig. 7. A group of the spores of Exosporium scolecomorphum, n. sp.



Fairman — NEW OR RARE FUNGI



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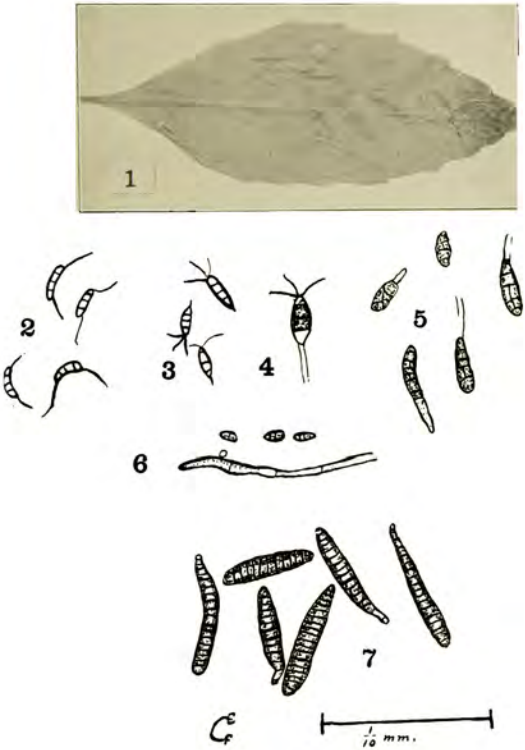

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THE PINNACLE HILLS

OR

THE ROCHESTER KAME-MORAINE

BY HERMAN L. FAIRCHILD

CONTENTS

INTRODUCTION; HISTORICAL

The singular range of hills at the south border of the city of Rochester is the conspicuous relic of the most dramatic episode in the later geologic history of the region. The hills are the product of the great ice-cap, or continental glacier, which only yesterday, in relative time, buried this area. After millions of years of mild climate had prevailed over the continent some slight variation in climate changed the rainfall of eastern Canada to snow; and the accumulation of tens of thousands of years of snowfall made the Quebec ice-field, which overspread all of New York, New England and the Great Lakes area.

This slowly spreading ice-sheet gathered up from the surface of the invaded territory an immense quantity of rock-rubbish, which it distributed over the land on the southward, or piled at the melting border of the glacier. The most southerly accumulation, known as the "terminal moraine," lies chiefly in Pennsylvania. The Pinnacle range is a part of one of the later lines of deposition marking a pause and readvance in the recession of the ice front. It is, speaking correctly, a recessional or retreatal moraine, built at the southern edge of the waning ice-sheet while the latter yet overspread the site of Rochester and all of the northern land. The Pinnacle Hills are part of the Albion-Rochester moraine, the most northerly well defined moraine in the western end of the State.

The "Pinnacle" is the highest and the central point of the range of hills, and lacking a better name the whole line of hills has been called the Pinnacle Hills. Rising abruptly from the fairly smooth plain on which the city stands, this stretch of hills is the bold, upstanding topographic feature of the Rochester district. Only two other physiographic features about Rochester can compare with the range for size and interest. These are the Rochester Canyon of the Genesee River, and the Irondequoit Valley, the latter being the ancient or Pre-Glacial channel of the river.

Not only are the Pinnacle Hills the only hills about Rochester, and the highest and most conspicuous ground within many miles of the city, but they constitute the most striking, interesting and legible record of the Glacial Period found in this region.

Being the only conspicuous elevations found in the Rochester district the hills must have been recognized early in the settlement of the city. In an old deed, of year 1829, (Book 16, page 353, County Clerk's Office) the summit is called "Mount Monroe." But in O'Reilly's History of Rochester, 1838, the "Pinnacle" is casually mentioned as if commonly known by that name.

The earliest mention in geologic literature appears to be in James Hall's Second Annual Report of the Fourth Geological District (Assembly Document No. 200, 1838) page 328, where he says: "The highest of these hills in Monroe County is the Pinnacle, about two miles east of Rochester." Correctly, the direction is a few degrees east of south from the center of the young city, the "Four Corners," and much higher grounds lies in the southeast part of the county.

In Hall's classic volume on the Fourth District, 1843, page 323, he gives a sketch by Dr. G. W. Boyd of a section "about two miles east of Rochester," apparently the cutting at Monroe Avenue. The rough sketch and the comments are not correct. Glacial science did not then exist.

Some description or comments by Chester Dewey would be interesting, but nothing has been found.

With their conspicuous position, unusual topography and complex structure, these hills had not escaped the notice of glacial geologists. But the earliest recognition of their nature was by Professor Charles R. Dryer, in his article, "The glacial geology of the Irondequoit region" (No. 1 of the attached bibliography). He depicted the range in a sketch-map of the Irondequoit-Victor region, and devoted a paragraph of 14 lines, describing the hills as a "gigantic kame," which was a fairly correct diagnosis. His statement that the "lower half is composed of coarse gravel and the upper half of sand" is incorrect, when the whole range is considered.

Not until 1892–93 did anyone venture a detailed description or explanation of their origin. In August, 1892, the American Association for the Advancement of Science and the Geological Society of America met in Rochester. The geologists in attendance visited the range and discussed its formation briefly in Section E of the Association. At the December meeting of the Geological Society at Ottawa, Canada, Mr. Warren Upham read a paper describing these and other deposits of the region under the title "Eskers near Rochester, N. Y." This paper was published in the second volume of these Proceedings. (No. 2 of the bibliography.) In that paper Mr. Upham described the hills in some detail and concluded that the range was an *esker,* or deposit made in the bed of a glacial stream; "and that the esker was deposited in a deep ice-walled gorge, open above to the sky, eroded in the border of the ice-sheet by the melting action of the running water." (page 196.) Due to lack of topographic map and to inadequate study of the hills, this diagnosis was wrong. The deposits were not left as laggard deposits in the bed of an overloaded stream, but were built along the edge of the melting ice-sheet, as a typical frontal moraine.

In 1895 the writer published an article in the American Geologist (No. 3), proving that the range is a gravelly moraine ,or "kame-moraine." Excepting a sketch map of the district (figure 2 in this paper) the article had no illustrations.

The attached bibliographic list gives references to the later brief papers, or extracts, in print.

In several stretches of the range it has been deeply excavated for sand and gravel, and while this has revealed the structure of the deposits, as shown in the accompanying illustrations, it has unfortunately marred the form and beauty of the hills. In a few years some parts will be wholly destroyed, all the range will be occupied for residence or park purposes, and the interesting structures made by the glacial agencies will be lost to view. Hence it is desirable that the photographs taken during the past 30 years should be published as a permanent record of the form, composition, structure and origin of the Pinnacle Range.

The story of the Pinnacle Hills includes such complexity of geologic processes that it cannot be told as a continuous narrative, and the reader must therefore be prepared for some repetition. It involves the glacial history of the region previous to the time covered in "The Rochester Canyon," pages 1–55 of this Volume. These two papers, with those by Chadwick and Giles (9, 10), cover the Pleistocene history of Rochester and vicinity.

Glacial Terminology

The description of the Pinnacle Hills and the story of their making necessarily becomes a dissertation in glacial science. Like other sciences Glaciology has its own distinctive terminology, and for accuracy and conciseness in this writing many of the technical terms must be used. For the reader's convenience and general information the terms which will be used are defined in the following list.

Bowlder Clay. See Till.

Channel. The bed or path of a stream.

Crevasse. Fissures in the glacier, due to differential flow. With reference to the direction of ice-flow they may be longitudinal or transverse.

Debouchure. The termination or mouth of a stream. Debouchment.

Dip. The downward inclination of beds away from the horizontal plane.

Débris. Materials derived from the destruction or breaking-down of rocks. Includes a variety of special forms.

Detritus. Literally, materials derived from attrition or wear, but applied broadly to all rock materials carried by moving water; as bowlders, cobble, gravel, sand, silt or clay.

Drift. Strictly, any material which has been carried from its original place. Applied in geology to the rock-rubbish transported by glaciers or glacial streams. The term is a relic of the old theory of a century ago that the glacial deposits were brought down from the far north by imaginary floods, enormous debacles of water.

Drumlin. Masses of subglacial till, built up by the moving ice-sheet under unusual combination of mechanical conditions, when unable to carry further all its load of drift. Varying in form from domes to slender ridges; convex profiles; longer axis parallel to the ice movement. Word of Irish (Gaelic) origin, meaning a little ridge.

(See Bulletin 111 of New York State Museum.)

Englacial. Applied to the drift which was carried within the mass of the ice-sheet. See "till."

Esker. A term of Irish origin, applied to the ridges of water-laid materials, usually coarse, laid down in the beds of heavily loaded streams that drained the melting ice-sheet. Sometimes miles in length, and sometimes interrupted or forming a string of kames. Often terminating in a group of kames, to which the esker is related, as the feeding stream. In general they parallel the direction of flow of the ice-sheet. Perhaps some were laid down in ice-walled channels, open to the sky, but certainly most of them were built in tunnels at the bottom of the glacier. When the ice-walls melted the detritus crumbled to a ridge.

(See paper by Giles, No. 12.)

Fault. The structure produced by displacement, dislocation or shifting of rock masses, or any geologic deposits, along a plane of fracture.

Frontal Moraine. Any accumulation of glacial drift at the terminus of a valley (mountain or alpine) glacier, or at the margin of a continental ice-sheet. These may be "terminal," as the one formed at the maximum advance of the glacier; or "retreatal" or "recessional" when formed at lines of ice-front recession. The Pinnacle Moraine is retreatal. See "Moraine."

Glacial Lake. A water-body held up by the damming action of a glacier. Almost non-existent today. They formed in valleys or depressions which declined toward the ice front. (See Glacial waters in central New York, N. Y. State Museum, Bulletin, 127, 1909.)

Glacial Stream. A stream flowing from the melting glacier. See "ice-border drainage."

Glaciation. The work of glaciers, in general. Especially applied to the planed and striated surfaces of rocks, features peculiar to the action of moving land ice.

Glacier. A field or stream of ice, formed from snowfall in a region of perpetual snow, and moving down a slope or spreading by its own weight. Having peculiar structure due to the differential or unequal flow; and transporting rock-rubbish (drift). Classified as "valley," "alpine" or "mountain" when originating in mountains and flowing down valleys; "continental" when covering vast areas, like Greenland or Antarctica; and "piedmont," applied to the Malaspina glàcier in Alaska, which is an ice-field fed by valley glaciers from the Mt. Saint Elias alps.

Ground Moraine. An old name for subglacial drift. See till.

Ice-Border Drainage. Stream-flow along the side or the front of a glacier. In the case of valley glaciers such flow is marginal. In New York such flow was along the front of the continental ice-sheet where the exposed land surface sloped toward the ice-front. In some cases these streams were large rivers. (See N. Y. State Museum Bulletins Nos. 105, 127, 160, 209–210.)

Ice-Laid Drift. Another name for "till."

Interlobate Moraine. Morainic deposit between two contiguous or colliding lobes of an ice-sheet. Type example is in Wisconsin. Very rare in the east.

Kame. A term of Scottish origin. Now applied to mounds, knolls or hills of water-laid drift. They are outwash from the glacier, built at mouths (debouchure) of glaçial streams, and mostly into standing water. Of the nature of incipent deltas. Related to "eskers." See Kame areas in western New York. Jour. of Geol., Vol. 4, 1896, pp. 129–159.

Kame-Moraine. A moraine which is partly or largely, water-laid drift, or kame knolls. The Pinnacle Hills are example.

Kettle. Basins or bowls, or sometimes large and irregular depressions, due to the melting away of enclosed or buried blocks of ice which had become detached from the ragged ice margin.

Characteristic of morainal, and especially of kame, deposits. Must not be confused with "potholes," which are holes drilled in the rock beds of streams by eddies of water armed with hard stones.

See "Kettles in glacial-lake deltas." Jour. of Geol. Vol. 6, 1898, pp. 589–596; and paper No. 9.

Moraine. Masses of rock-rubbish accumulated at the edges of glaciers, by the work of either the ice or the glacial streams; that is to say, they may be both "till" and "kame." As regards position they are frontal, lateral, medial or interlobate. According to manner of accumulation they may be pushed, dumped, etc. In this region we have only the frontal variety.

Morainal Lake. A body of water held by the damming action of moraine drift. The tens of thousands of lakes and lakelets in the northern, glaciated, areas are properly called "drift-barrier" lakes.

Morainal Apron. A term formerly applied to the sandplains in front of some moraines. See "outwash."

Outwash. Detrital materials swept out of the melting glacier by the streams draining the ice. The term is loosely applied to the water as well as to the drift burden. Also called "overwash." It may be in the form of sandplains, of true deltas, or of kames; or it may be carried far down valleys as "valley train" drift.

Proglacial. Having position in front of a glacier, or beyond the ice margin.

Retreatal Moraine. One of the successive frontal moraines built during pauses, and frequently with readvance, in the waning and shrinking of the glacier. See "moraine."

Subglacial. Beneath the glacier, or held in the bottom portion of the ice. See "till."

Striae; Striations. Scratches, grooves or furrows produced on either bed-rock or the transported stones by the rubbing and grinding action of the moving land ice. Characteristic of glacial work.

Superglacial. Applied to the drift borne at or near the surface of the glacier. See "till."

Terminal Moraine. See "frontal moraine."

Till. Drift deposited directly by the ice. Unassorted rock material of all kinds and sizes. According to position in the glacier is classed as subglacial, englacial and superglacial. The more compact subglacial till was formerly called "bowlder-clay" and "ground-moraine."

Water-Laid Drift. Materials deposited by direct action of water. Usually more or less assorted in size, and stratified. Fragments are rounded by attrition in transportation. See "detritus."

Outline of the Glacial History

During the enormous length of time represented by the record contained in the rock strata of the globe, covering probably some hundreds of millions of years, the atmospheric conditions, or climatic factors, had considerable variation. Periods of low temperature and severe glaciation occurred in very ancient geologic time, and at long intervals down to the present. We are living in the latest cold period, called the Pleistocene, for glaciers are lingering in all quarters of the earth.

In Tertiary time, preceding the present cold period, the climate was mild, even in the polar regions. Then, through some causes not yet fully known, there appears to have been a slight fall in world temperature, perhaps accompanied by high land elevation in Canada. Excessive snow replaced rain in some regions, and eventually permanent fields of snow-ice formed in the district of heaviest snow fall, thus initiating the continental glaciers which invaded the northern United States. It should be realized that in cooler climates snow is as normal as rain, and that ice fields or glaciers are just as natural as lakes. But, what is important, the glaciers form on high ground where water could not stand. The lowering of our present average annual temperature a very few degrees would quite certainly cause another ice-cap in Quebec, adjacent to the path of the cyclonic storms which pass northeast down the St. Lawrence valley.

The Glacial Period of the present time, or Pleistocene, did not produce merely a single ice-sheet, but included a series of cold, or glacial, epochs with warm or mild interglacial epochs. It is believed that several ice-sheets successively invaded the region of the Great Lakes and the upper Mississippi Valley. The latest ice invasion, to which we are indebted for all the glacial features in New York had its center of snow accumulation in eastern Canada, and is called the Quebec glacier (formerly called Labradorian).

At its maximum development the Quebec ice-cap buried all of

New England, all the Great Lakes area and practically all of New York. The spreading flow of the ice-sheet over central and western New York was, in general, from the northeast; but the latest movement, of the thinner, marginal portion, was directed by the stronger topography, and the latest flow in the district of the Finger Lakes was parallel with the valleys.

The geologic effect of a glacier is partly erosional, but chiefly transportational. It rubs down some of the minor inequalities of the land surface, picks up loose materials, and thus incorporates great quantity of rock-rubbish. This transported drift must eventually be dropped at the terminus of the ice-sheet, and is sometimes amassed as frontal moraines.

The southernmost reach of the Quebec ice-sheet is marked in Pennsylvania by a belt of drift, known as the "Terminal Moraine." (See figure 1.) In some localities this has the form of ridges and knolls, similar to the Pinnacle Hills, but over most of the distance it is an indefinite, scattered deposit.

East and southeast of New England the ice-sheet pushed into the sea, and the terminal moraine lies beyond the marine shoreline. Along the north side of Long Island it forms the belt of hills which makes the backbone of the island. It crosses the Hudson Valley at the Narrows, south of the New York Bay, comprising the hills which make the constriction in the valley, on which are located the fortresses that guard the entrance to New York harbor. Across New Jersey the moraine passes northwestward, continuing across the northeast part of Pennsylvania to Salamanca, N. Y., and from there turns southwestward along the Allegany and Ohio valleys to southern Illinois; and then swings northwest.

Tens of thousands of years must have been required for the Quebec ice-sheet to creep down from the northland, with its pauses, retreats and readvances, due to variations of climate. After the long standstill at the terminal belt the removal of the ice-sheet must have been in a similar slow and hesitating manner. We may not properly speak of the "retreat" of the glacier, as the ice-body was always pushing southward. The front of the glacier receded or retreated when the wastage of the ice by melting exceeded the supply by the southward flow, and it readvanced when the flow exceeded the melting, thus producing long-period oscillations of the margin. The lines of heavier drift, the retreatal moraines, mark the longer or more persistent readvanced positions. In the southern part of New York the moraines are scattering and dis-

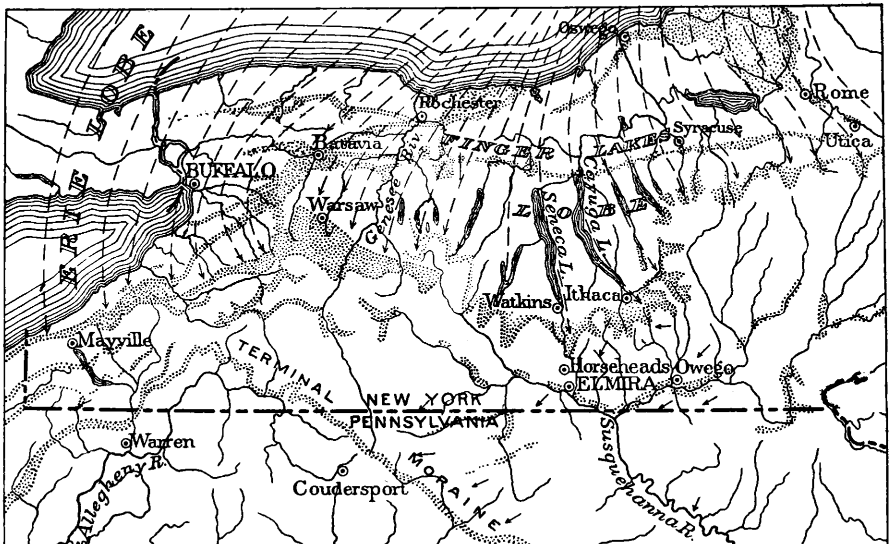


FIGURE 1. *Moraines in Central and Western New York*

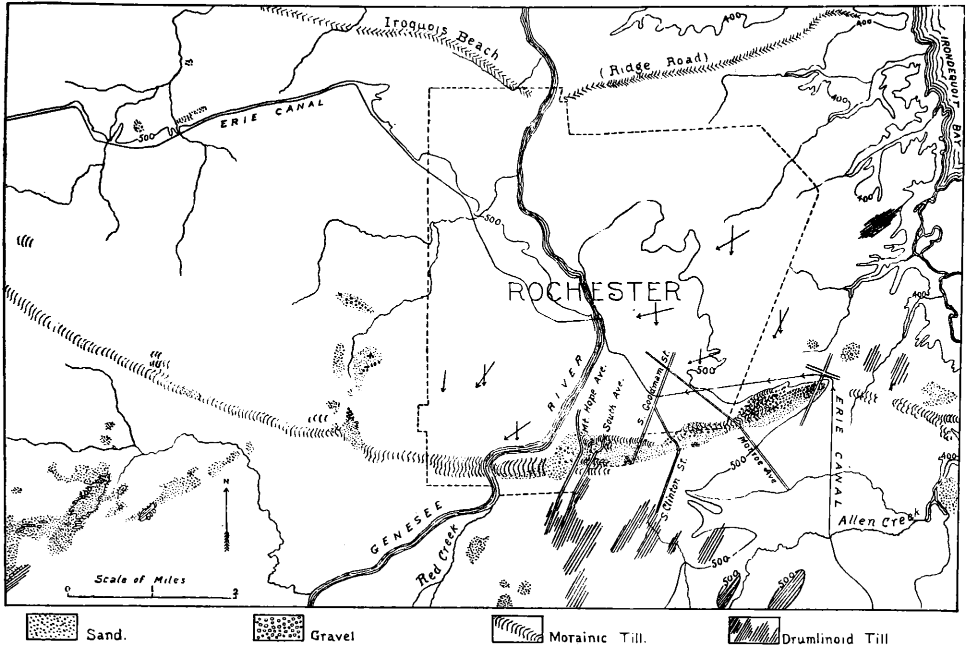


FIGURE 2. *The Pinnacle Hills; Albion-Rochester Moraine*
The arrows show directions of the glacial flow. The city boundary is that of 1895

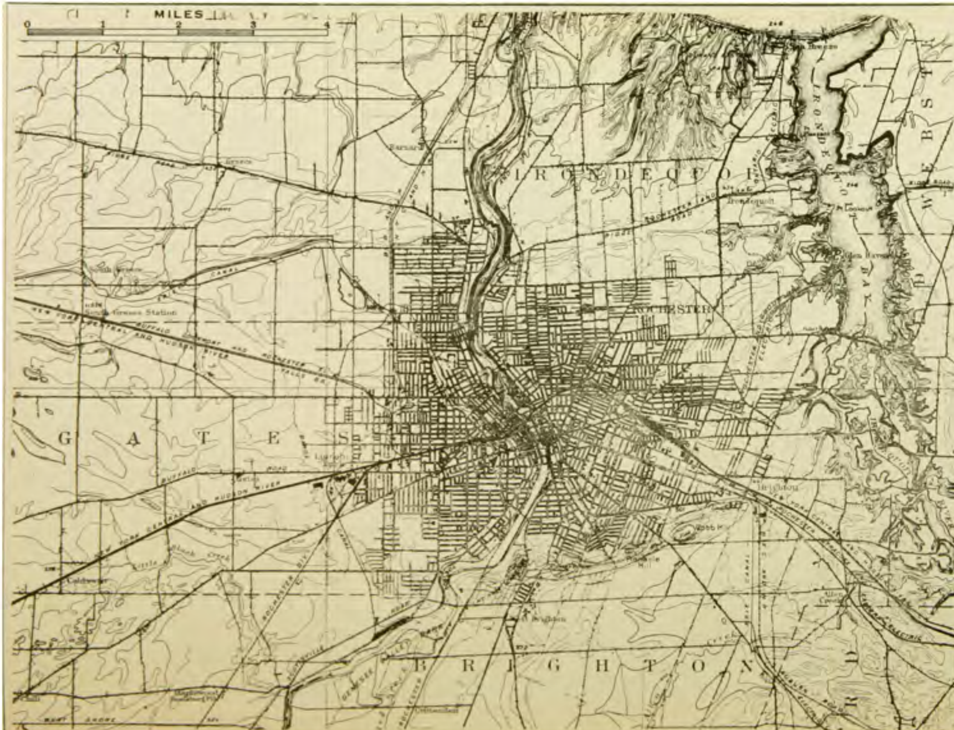


FIGURE 3. ***Physiography of the Rochester District***
From the Rochester topographic sheet

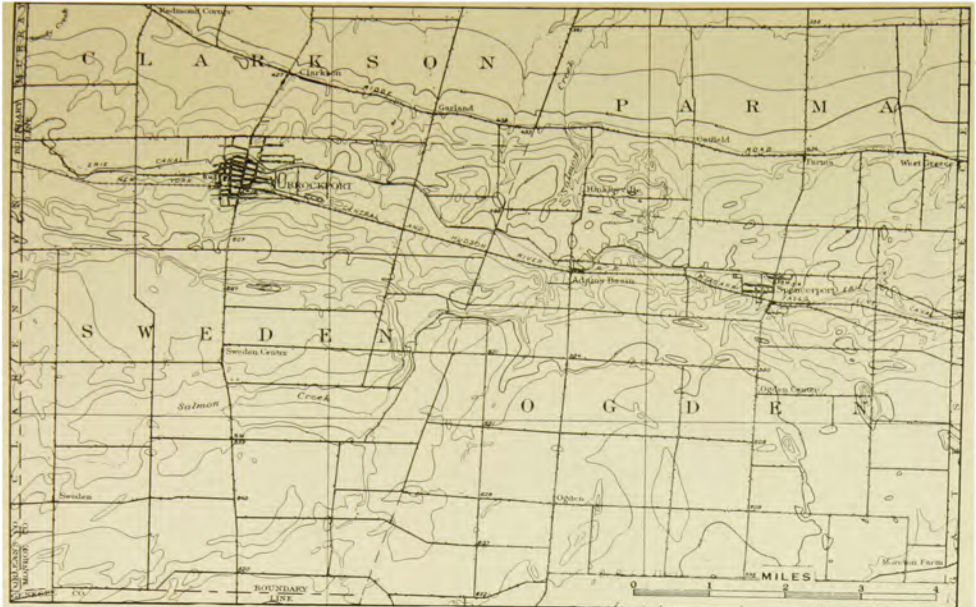


Figure 4. *Westward Extension of the Moraine*
From the Brockport topographic sheet

continuous, partly on account of the hilly surface and strong relief in the southern counties. The sketch-map, figure 1, shows a line of moraines in the valleys of the Chemung and Susquehanna.

The heaviest of the recessional moraines forms the massive deposits at the south ends, or heads, of the central New York valleys, constituting the present divides between north and south drainage. These moraine fillings in the valleys are conspicuous from all the railways and highways leading south. This "Valley-Heads" moraine lies just south of Dansville, and crosses the Genesee Valley at Portage, where it is wide and massive. It is this moraine that blocks the ancient valley and has forced the river into the new channel, the Portage Canyon. The moraine lies close south of Warsaw and then swings southwest to join other drift belts along the steep slope facing Lake Erie.

A morainic belt stretches eastward from Batavia, and includes the Mendon Ponds kame-area (figure 5); the drift hills in the south end of the Irondequoit Valley; the heavy gravels of Baker Mill, north of Victor; and probably the Junius Ponds kame-area north of Geneva. This drift belt is responsible, at least in part, for the blocking of the Pre-Glacial valley of the Genesee in the Rush-Mendon district, thereby diverting the river into its present channel through Rochester.

As stated above, the Pinnacle range is a part of the Albion-Rochester moraine; and is the latest morainic belt well-marked in the western end of the State. It is possible that later moraines lie under the waters of Lake Ontario.

Since the Quebec ice-sheet disappeared, some tens of thousands of years ago, the climate has been milder than today, as evidenced by the abundant remains of elephants in Alaska and northern Siberia, and by a subtropical fauna in England. The present is a time of refrigeration.

General Description of the Range of Hills

Location; Form; Dimensions; Altitudes

In restricted use of the name, the Pinnacle Hills extend from the village of Brighton, on the east, to the Genesee River, a distance of four miles, with the general direction west 15 degrees south. As a whole the belt has a decided linear form, with some curvature, convex southward.

The east end at Brighton is definite, partly due to the erosion by Lake Dawson (see page 2 and page 12 of this volume). The Erie Canal, now converted to a subway for the railways, made a sharp bend in passing around this eastern terminus. The western terminus of the hills, at the river, is not, however, the end of the moraine, which extends westward beyond Albion and Medina. (Figures 1–4.)

The range is not of uniform width and volume, but is a series of knolls, or groups of knolls and irregular ridges, of distinctly morainic character. (Figure 2.) Three main divisions of the range are recognized. First, the Brighton-Cobbs Hill group, extending from Brighton to Monroe Avenue. Fortunately the greater part of the group is now conserved as the Cobbs Hill Reservoir Park. The eastern portion is a fine example of morainal topography, with a number of handsome kettles. Cobbs Hill before it was truncated for the reservoir had two crests (plates 44, 46), the northern and higher being 663 feet elevation above tide. The sag which was cut for Monroe Avenue had original elevation 560 feet. The plain north and south of the range is 500–520 feet.

The second division is more compact, containing the "Pinnacle" high point, which has elevation 749 feet, about 230 feet over the city plain. It extends from Monroe Avenue to about one-fourth mile west of South Clinton Street (formerly called Pinnacle Road). The cutting for Clinton street, and especially the extensive excavations both east and west of the street, have pitifully marred the ridge. (Plates 57, 61, 62.) The old Catholic cemetery yet holds the north slope east of the street.

The third division includes the remainder of the range, westward to the river, and is broader and less definite. In succession, westward, it includes the knoll east of South Goodman Street; Highland Park, between Goodman Street and South Avenue; the "Warner Tract," between South and Mount Mope avenues; the Mount Hope Cemetery and "Oak Hill," which extends to a bend in the Genesee River. In this division the highest points are the knoll which carries the Memorial Pavilion, 650 feet, and summits in the Cemetery up to 675 feet. The water surface in both the Cobbs Hill and the Highland (Mt. Hope) reservoirs is 636 feet.

The irregularity of the range is great, in both lengthwise and crosswise sections. Only at the Pinnacle is the cross-section a single ridge; and this is better described as an elongated and irregular mound. The crestline or longitudinal profile is very irregular, with extreme vertical variation of about 190 feet. The northern slopes of the range are the most irregular, with spurs and deep ravines, partly erosional and partly the form of the ice-contact. Some of these slopes are as steep as the coarse material will stand, 25 to 30 degrees. The southern slopes are usually less steep, while the lower portions are fairly smooth and uniform, blending with gentle inclination into the plain on the south, which was lake-bottom. These lower southern slopes are the glacial outwash, and were laved by the glacial lake waters (Plate 53).

One peculiar and important geologic feature is the presence of many deep basins or kettles, which are especially characteristic of morainal deposits. No better examples of mound-and-basin topography may be desired than occur in Mt. Hope Cemetery and in Reservoir Park. East of Goodman Street two large kettles on the low ground at the north side had impervious bottoms, one holding a lakelet (plate 67), and the other a peatmarsh. (Paper No. 9.) Both of these very beautiful and interesting features have been destroyed by the march of human "improvement."

To find any ground equaling the height of the Pinnacle we must go south seven miles, to the kames about the Mendon Ponds; or southeast ten miles to the hills south of Fairport. On the parallel of Rochester no equal elevation is found short of the hills north of Oneida Lake, 100 miles away, or westward 30 miles to the drumlins north of Elba, in Genesee County.

Composition and Structure

No existing glacier fully illustrates the behavior and work of the ice-sheet which covered this region. The glaciers of alpine districts exhibit the peculiar work of moving ice-streams in mountain valleys, but they do not have the volume, sweep and broad intensive effects of the vast ice-cap which overwhelmed Rochester for scores of thousands of years. The continental glaciers of Greenland and Antarctica illustrate the general character of the Quebec glacier, but these high-latitude ice-caps probably have a behavior at the margins unlike that of the Quebec, in our lower latitude, under the summer heat of more nearly vertical solar radiation.

The materials composing the range are so various and of such irregular structure that a brief description is inadequate. In composition the range is not wholly the sort of jumbled rock-rubbish, or till, which is deposited by the direct mechanical work of the ice. It is largely sand and gravel, dropped at the ice margin by the copious streams which drained the melting ice-sheet. During their flow of miles, back within or beneath the ice-sheet, the streams acquired a great volume of detritus, which they had to drop at their debouchure. The earliest construction, forming the base of the range, was in standing water, in a glacial lake that lay over the territory on the south. Hence the basal beds of the range, wherever exposed and undisturbed, are horizontal sand or gravel. At the time of this deposition the front of the ice-sheet might have been at least some little distance northward. The bulk of the knolls are coarse gravel, and therefore kames. The ice-laid drift or till is a minor quantity, and occurs mainly on the summits of the ridges and along the northern base. A late readvance of the ice-sheet produced a push and thrust against the north flank which has crushed, crumpled and in some places mingled all the deposits. In some stretches, certainly at Brighton and Cobbs Hill, the ice overrode the hills and left very heavy and bowldery till on the summits. (Plates 33–37, 47–50.) In many excavations, especially on the north flank, the original bedding is found to be tilted, faulted and veined, or even crumpled into a structureless mass (plates 42, 50, 60, 63–65).

Blocks of local limestone (Niagara) occur on the apex of the Pinnacle, and on other high points, and in prodigious numbers on the crests of the Cobbs Hill ridges (plates 46–49) and on the summit of the Brighton hills. As these were carried by the ice but a short distance, only two or three miles, they did not suffer much wear, and are mostly angular; although some of them are planed and scored.

In this anomalous structure of the range we have clear proof of some oscillation of the ice front. The lake beds at the base prove the absence of the ice, while the till and bowlders at the crests of the ridges, and the crushed sands and gravels, are equally clear proof of a readvance.

Along the north side of the range in some stretches, as by the eastern "wide-waters," and at Goodman street, are small ridges and mounds of till which mark the last stand of the ice edge before it made its final and rapid retreat.

The larger percentage of the gravel and cobble, sometimes one-half, is Medina, the only supply of sandstone which the ice-sheet found this side of Canada. This red Medina also constitutes a large part of the sands, giving a reddish color to most of the coarser deposits. The silt and clay, derived from the very thick shale strata in the Ontario Basin, were mostly swept out by the drainage into the lake waters on the south, forming the clays that furnished the supply for the brick factories on Monroe Avenue and at Maplewood, west of the river; and the thick clay and silt of the plain on which is located the Medical College and Hospital of the University of Rochester.

Upon the north flank of the hills, and even to the heart and summit as shown at Monroe Avenue and at South Clinton Street, the beds have suffered great disturbance. In the coarse gravels this is shown by the loss of all stratification; and in the sands and silts by their contorted, tumultuous, disordered character. In all the pits much faulting is exposed. This is the more common sort of disturbance in the deeper portions of the range, which in some sections gives very complicated forms and surprising brecciated structures (plates 32, 60, 64). The sand beds along the south flank of the range are usually approximately horizontal and without much faulting or other disturbance.

The best general statement regarding the distribution of the material is, that the coarser deposits lie along the north side of the range, while the base and the southern slope are mostly fine sand and usually undisturbed. This will be explained in the next chapter.

The original dip of the water-laid beds is not lengthwise of the range, or westward, nor away from a median line, as would be the case in esker construction, but is generally southward, or across the range. (Plates 30, 40, 43.) Some of the steeper dip along the north flank was produced by the push of the ice-front in its last readvance.

At the east end of the range, at Brighton, the gravels dip in different directions. In the large pit on the southwest side of the Pinnacle 80 feet of the lower gravels have a dip 12 to 15 degrees east of south. There are many exceptions to the prevailing southward dip, mostly in the gravels. Some sections show inclinations in several directions. It is evident that some of the local variation is due to some sort of interference subsequent to the deposition. The interfering factors are, the thrust of the readvancing ice; faulting, by consolidation of the deposits; unequal settling by the melting of buried ice blocks and frozen masses of the deposits: and slipping or slumping of the steeper upper beds.

The ice-front was subject to rapid change in form and position during the summer melting, and the shifting flow of the waters probably tended to pile the coarser materials into conical masses thus giving the beds steep inclination in various directions. Probably most of the glacial outflow was subglacial, the streams emerging from tunnels beneath the ice sheet; and sometimes being under hydraulic pressure. When such streams poured out into standing water their detritus was partially piled in masses or mounds, as kames. These conditions may explain the variable original inclination of the sand and gravel beds. But very steep beds, approaching the vertical, must, like folds and faults, be attributed to some disturbance subsequent to the deposition (plate 65).

Morainic Characters

The morainal succession across the State, from south to north, and the position of the Rochester moraine as the latest of the series, are shown in figure 1.

The origin of the Pinnacle range as a frontal moraine implies its continuation east and west, and such extension is seen in figures 1–3. Southeastward from Brighton the ice front has apparently left its record in till ridges and bowlder-fields, until intercepted by Irondequoit Valley. Beyond the valley, in Penfield and Walworth, the moraine is a wide, scattered belt with conspicuous bowlder-fields of Niagara limestone, often piled in large masses.

West of the Genesee River the moraine continues the curving, arcuate line of the Pinnacle range. It includes a belt of knolls and gravel deposits along Brooks Avenue, and as far as the Buffalo, Rochester and Pittsburgh Railroad. West of the railroad the moraine is a fairly distinct ridge of stony drift, with northwest trend. Toward Spencerport the moraine becomes an irregular belt of hills and short ridges, and so continues past Adams Basin, Brockport, Holley and Albion (figure 4). The irregular and stony surface seen along the Falls Branch of the N. Y. Central Railroad from South Greece to Holley is the moraine. From Holley to Albion the north edge of the moraine lies a mile south of the railroad.

Glacier ice flows as a plastic body, and the glacier margins conform to the larger features of the land surface. Such conformation must have been pronounced in this lower latitude. Lobes or tongues of ice were pushed into the valleys, with reentrants of the ice-front on higher points. This implies that a strong ice-lobe should have occupied the capacious Irondequoit Valley. We find the beginning of the moraine which was laid along the west side of that lobe on East and Highland avenues to the Kelly Road. Beyond this the drift was scattered by the Dana lake waters and the succeeding lakes Dawson and Iroquois, or is buried under the lake deposits. In Professor Chadwick's paper on the Irondequoit (10 of the appended list) his plate 4 depicts a later stage of this Irondequoit lobation., It must have been blunted by the melting and buoyant action of the deep lake waters.

The glaciated surface of the limestone of the Rochester plain is found to carry two sets of striae. The stronger and older set has direction south 40° to 60° west. Another set of scratches, later and lighter, sometimes no more than a polishing, has radiating directions perpendicular to the Pinnacle range. Theoretically the flow of the marginal ice is normal to the line of ice-limit. The older set of striae was made when the ice-sheet extended far south and was unaffected by the topography of the Rochester region. The later set records the spreading flow and the weak abrasion of the thinner ice when the moraine was building. West of the Genesee River the latest ice movement was S. 5°–15° W., as shown in several places. Figure 2 shows by the arrows the direction of the striae.

The compact, linear form of the Pinnacle range is in striking contrast with the continuation of the moraine west of Spencerport and east of the Irondequoit. This difference is due to the fact that the Rochester moraine stands on somewhat lower ground, and was washed and limited by the Dana Lake waters. Apparently along this stretch the ice-edge had been forced back by the lake, because it was weak on account of the lines of drainage, which built the kames.

The comparison of the arcuate moraine from Brighton to near Spencerport is also in contrast to the Mendon Ponds kame area (figure 5), eight miles south, with its correlating groups east and west (plate 2 of this volume).

General Conditions and Relations

Our knowledge of the constructional process in moraine-building is derived from observation of such work by the existing glaciers. The piling of drift by the melting ice can be seen at the terminus of any mountain glacier, like those of Switzerland, but the broad-fronted glaciers of Alaska give better illustration of the work of the Quebec glacier.

From the activity of the living glaciers and study of the relics

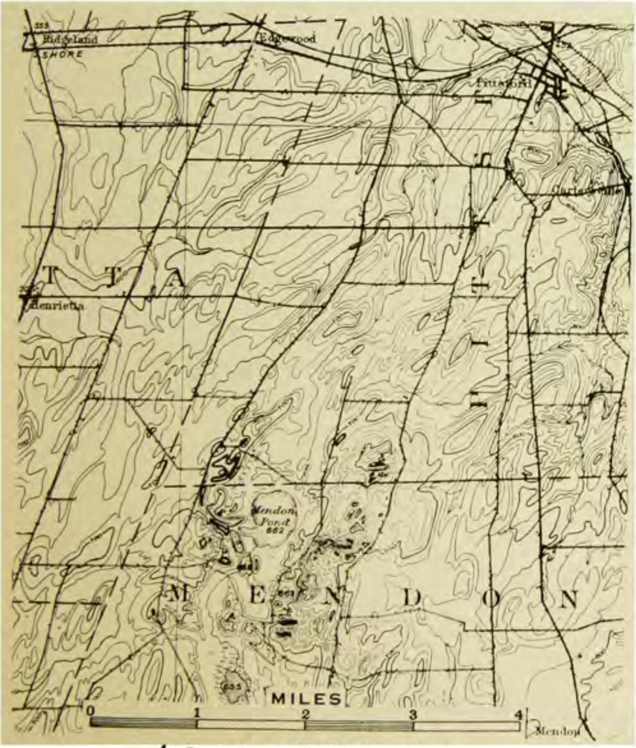


FIGURE 5. *The Mendon Kame-Moraine*
From the Rochester topographic sheet

of the ancient ice-sheets the science of glaciology has been built. We find that the deposit left directly by the ice is a heterogeneous mixture of rock fragments of all sizes and shapes, and of all the various kinds which the mountain glacier gathers from the valley-walls, or which the continental glacier acquires from the overridden land surface. Many of the stones are scratched and planed by friction among themselves, or by contact, under pressure, with the bed-rock beneath the glacier. Glaciated stones are alone sufficient evidence of ice-work, as no other geologic agency can produce these peculiar structures.

The material beneath the ice-sheet, or held in the lower ice, has been subjected to intense grinding pressure, and may be largely pulverized rock, or "rock flour," forming a clayey or pasty mass, charged with striated stones. This subglacial drift, or "ground-moraine" is also peculiar to ice-work. Farmers call it "hardpan." Streams flowing from glaciers have, after they drop their coarser burden, a milky or opalescent tint due to the suspended "rock flour," the product of the "glacial mill," which is not true clay; the latter being a product of rock decay.

The drift borne within the ice, englacial, or on the surface as superglacial, is less compact than the subglacial, and the mass of rock-rubbish piled at the ice margin as a moraine is largely this looser and incoherent drift. But to all the varied deposit left by the ice itself, whether loose or compact, the geologist applies the name "till."

However, the greater part of the Pinnacle moraine is not ice-laid drift, or till, but is sand and gravel, and hence is water-laid. The fact is evident in the many excavations for building materials. On first thought this fact might appear inconsistent with the glacial origin of the hills. But it should be understood that the ice disappeared by melting, and that turbulent and muddy rivers poured from the glacier, especially in summer, carrying very heavy loads of detritus.

In districts where the land and the valleys sloped away from the ice margin the glacial streams bore their loads of sand and gravel down the slopes, and swept the finer material even to the ocean. Such was the condition when the glacier front was lying across the country in the southern part of the State, where we find the south-leading valleys deeply filled with the glacial outwash. The Cohocton Valley, below Wayland and Cohocton, is a fine example.

In districts where the down-slope of the land was toward the glacier, thus producing a basin between the glacier and the highland, standing water, as glacial lakes, was held up by the ice front;

and when the glacial streams emerged from the ice they had to drop their burden in the lake. This relation is the key to the origin and structure of the Pinnacle Hills.

From the time that the ice front had receded north of the present divide between waters flowing south toward Pennsylvania and those flowing north to the Ontario Basin it had been faced by a series of glacial lakes. The story of these waters has been told in several writings (see N. Y. State Museum Bulletin 127, 1909). These glacial waters, with falling levels, sometimes escaping west to the Mississippi and sometimes east through the Mohawk Valley, had fallen away until at the time when the ice front stood at the line of the Pinnacle range relatively lower water faced the glacier. These waters were a phase of Lake Dana, which had its control at Marcellus, in the Otisco Valley. The theoretic altitude of the Dana level is here about 725 feet. The eastward escape would have been through the valley at Victor. The next recognized lake is Dawson, with outlet by the Fairport-Lyons channel, with closing elevation 480 feet. The waters in which the Pinnacle Hills were built were either Lake Dana at its full height, or an early phase of its falling waters intermediate between Dana and Dawson. Into this shallow water was pouring the Genesee River, from the south, and the glacial drainage from the north. The silts and brickclays which overlie the till in the towns of Brighton, Henrietta, Gates and Chili are the commingled deposits from these two sources. Some material has come from northern Pennsylvania, and some from Canada and the Adirondacks.

This lake water laved the front of the glacier when the Pinnacle moraine began, and the sand strata spread out in the lake, and forming the base of the moraine, were the earliest deposits. On these were built the hills by the shifting torrential streams draining the ice-sheet.

When the ice-front lay over Henrietta and Brighton the ice probably was buoyed by the lake and wasted so steadily, by both melting and flotation, that little opportunity was given for any local or moraine accumulations south of the Pinnacle range. At the time of building the moraine the Ontario lobe of the Quebec glacier had become somewhat stagnant, and melting of the surface (ablation) had probably exposed the lower strata of the ice-sheet, which were heavily charged with drift from the north. When the balance was established between ice-flow and ice-removal the conditions were favorable for dropping the drift load rapidly and abundantly. The drift that under ordinary conditions might have been spread over a large area is concentrated in the narrow belt of the Rochester moraine.

As already stated, the form and structure of the hills suggest that they were built at a few centers of stream-work on the changing ice-front. Possibly the variable and shifting outflow from four or five principal outlets, spaced about a mile apart, could have produced the Pinnacle Hills in—shall we say, a century? The total amount of drift and detritus in the moraine is not great, comparatively, but it shows to full advantage because it rises conspicuously from a plain, instead of filling a valley or depressions in uneven ground. The Pinnacle Hills are only a minor part of the drift which has been left in the Genesee lowland and in the Irondequoit Valley.

The original slopes of the south face of the range, as made by the glacial outwash, must have been somewhat smoothed by the waves of the later waters of the lake. The slope shown in plate 53 shows the final effects.

Relation of Lake and Glacier

It is difficult to visualize the interaction of the glacier and the lake, and to know the actual conditions during the construction of the moraine. Three elements are concerned in the work: (1) the depth of the lake waters and their surface elevation; (2) the depth of the marginal ice or the elevation of the glacier surface, and the character of the frontal slope; (3), the position in the ice-front, and the manner of escape of the glacial streams which swept the gravel and sand out into the lake.

The elevation of the surface of the lake water in which the hills were built is not known with precision. It appears that the hills, with the exception of the Pinnacle, were submerged in the water, for the reason that we find no outwash delta plains or terraces, which would have been constructed if the water had been shallow, or the surface lower than the moraine deposits. As stated above, the recognized lake levels in this district are the glacial lakes Dana, here about 725 feet, and Dawson, about 480 feet. As the latter lies below the clay plain in Brighton and Henrietta, Lake Dawson was subsequent in time to the building of the moraine and therefore not concerned in that event. At full height the Dana waters would have overtopped all the range except the Pinnacle (749 feet). The base of the range is 500 feet at Brighton, about 520 feet at South Clinton Street, and 540 feet at the Genesee River. This gives a depth of water over 200 feet.

At Brighton the well-bedded sands extend up to 550 feet, but the capping of stony till suggests that considerable depth of lake deposits might have been eroded by the readvancing ice sheet. The knolls in Reservoir Park and in the Cobbs Hill area, are gravel, with bedding to high level (see plates 38–41).

At South Clinton Street the fine surface sands and gravel on the ridge west of the street show fair bedding at about 650 feet. At South Goodman Street the sands (plate 68) reach up to over 600 feet. Bowlders found in the higher sands prove sufficient depth of water to float the weighted ice-blocks which rafted the stones.

The highest peaks, the Pinnacle and the Mount Hope knolls, are either gravel or till. The coarse gravels imply strong currents to remove the sand, requiring either shallow water or land exposure.

The depth of water had buoyant effect on the glacier margin, and this probably assisted the thin ice in pushing the limestone blocks to the crest of the Pinnacle.

The earliest waters at the Pinnacle moraine were the highest, and they were certainly over 600 feet, and probably at or over 700 feet. The water level fell away when the glacier control in the Syracuse region allowed an escape for the waters lower than by the Dana pass at Marcellus. Apparently the drop was so prompt or rapid that wave erosion did not carve conspicuous or definite benches or shorelines on the south slope of the moraine. However, there is significant correspondence in height of some terraces and ridges west of the Pinnacle with elevation about 660 feet.

The vast clay plain south of the moraine carries the fine sediment which was laid in the deep water when the coarser materials were building Pinnacle range. There was no other possible source for such quantity of fine and glacial rock-flour.* West of the ridge which carries the State and County Buildings the plain fell within the area of the Genesee River, and some minor portion of the clay of the plain might have been contributed by the river. South

*A suggestion that the Pinnacle range is an interlobate moraine, with the Irondequoit lobation of the ice-sheet covering the Brighton plain west to the County Buildings and south to Ridgeland and Edgewood, has, in the opinion of the writer, no basis of fact.

of Elmwood Avenue the excavations for the University of Rochester Medical College and Hospital reveal deep silts and clay. At the surface some eight feet of silt; then some fifteen feet of chocolate colored clay, with lively reaction for carbonates. Beneath this is "quicksand," with coarse materials at the bottom, resting on the red Salina (Vernon) shale. The vertical succession of deposits gives the history, first from the ice-sheet, leaving either till or coarse outwash; then the deep lake waters and the rock-flour clays; followed by shallowing water and more sandy sediments. (See later chapter, on the Scottsville Lake.)

The intimate relation of glacier and lake is proven by the frequent occurrence of bowlders, some of great size, in the stratified sands, and even in the clays far out on the lake-bottom plain. Rafting by floating ice is the only explanation. (See plate 77.)

Ice Front Conditions and Deposition

The termination of Alaskan glaciers in the sea give some suggestion of the behavior of the Rochester ice-sheet when it was building the Pinnacle moraine in Lake Dana.

First we must recognize the peculiar structure and melting of glacier ice. Ordinary lake ice, or that produced by the freezing of water, has a massive, crystalline structure. When this ice is exposed to a melting temperature it liquefies only at the surface, while the unmelted part remains solid and firm. Glacier ice on the contrary has a coarse, granular structure, due to its origin from snowfall. When glacier ice is warmed to the melting point it melts throughout the mass, the granules separate, and the mass all breaks down. This explains the relative abrupt ending, or the bold front of glaciers.

At the position of the Pinnacle moraine the ice front was probably three or four hundred feet deep, and was faced by lake water perhaps two hundred feet or more in depth. The glacier front, therefore was not floating in the water, like the Greenland glaciers which produce the great ocean icebergs, but was resting on the land. The melting at the front of the granular ice produced, at least in the summer time, a general breaking down or rapid slumping into the lake.

The water of the lake had a singular melting action on the submerged ice. Fresh water is densest at 39 degrees, Fahrenheit. When it cools toward the freezing point of 32 degrees (under the ordinary pressure of the air) it expands, becomes lighter and rises. This property coats fresh-water bodies in winter with ice and with the colder and lighter water, and so prevents deep freezing.

When the water facing the glacier came into contact with the ice it was cooled, made lighter and rose. Such long-continued effect produced an upward flow at the ice-contact, and some melting of the submerged ice.

Probably most, or all, of the glacial drainage was subglacial, issuing from tunnels beneath the ice-sheet. This glacial outflow was probably near 32 degrees temperature, and increased the upward circulation, although reducing the melting effect.

During the winter and cold seasons, when the part of the ice mass which was exposed to the atmosphere and the sunshine was melting very little, if at all, the ice-front was probably steeper. By the continued melting under water the front might have become so steep as to overhang, and large masses might have toppled over into the lake, as small icebergs. But in the summers, when the melting above water was rapid and the ice-front was slumping, and more sloping, probably only small masses of the firm, blue ice floated out in the lake.

If the reader is to understand the conditions and geologic processes related to the moraine he must use the scientific or constructive imagination. He must see in his "mind's eye" the geographic features when the moraine was building. He must see the ice-front, irregular and drift-covered, extending east and west; westward past Albion and curving around the ice lobe in the west end of the Ontario Basin; and eastward past Syracuse and skirting the west flank of the Adirondacks. The site of Rochester is buried under, perhaps, 500 feet of ice. Over Brighton and Henrietta is a lake, with outlet through the valley at Victor, the waters of which lave the ice-front.

Will the reader now imagine himself as standing, at that not-far-distant time (speaking geologically) on some commanding point in Henrietta, with a field-glass in hand? Southward the hills rise into the till-covered upland, as today. East and west he sees a few islands rising from the shallow waters. But looking northward he sees the muddy waters ending against a slope of dark-gray color, the débris-covered ice-front. Further back the higher slope shows, in places beneath the rock-rubbish, the blue ice of the glacier; while the far-north horizon is an elevated surface of snowy whiteness, glittering in the pseudo-arctic sunshine or half obscured in cloud and mist. It is the same sort of view which may be seen today, in all essential features, in Alaska or in some Polar regions.

Examining the ice margin and moraine, with his field-glass, he would see that the muddy lake waters are greatly agitated at some points, where subglacial streams, under hydraulic pressure, emerge from beneath the glacier, contributing great quantities of detritus to be spread out beneath the waters as sand and silt. Other streams pouring out of the ice, or perhaps rushing down the surface of the ice-front, are building the higher gravel knolls. But even the latter may be submerged in the lake.

Now, will the reader imagine that he tired of the somber view, and went away; but returned years later? In general the appearance is much the same, but the glacier has expanded slightly and the ice margin has pushed southward so that the gravel knolls which at the time of his former visit were building at the ice edge or in the reentrant angles of the margin, beneath the muddy waters, are now half buried, or even wholly covered by the readvanced ice sheet. Without leveling the knolls or greatly removing the old deposits the plastic ice is overriding them, and capping them with massive, stony till; while huge blocks of rock, including the limestone of the Rochester plain, are being shoved up and left on the very summits of the highest hills. What he cannot see is that the overridden deposits are being mashed and crumpled by the push and weight of the ice.

In western Europe and Great Britain our ancestors saw similar spectacles, for perhaps many thousands of years. It is possible that the scene here imagined was actually observed by the original American. But geologists have not credited any "finds" of glacial man in America.

Detailed Description

Explanation

The more systematic and special study of the Pinnacle range was made by the writer during the years 1893–1900; and the following descriptive details of form and structure are largely from notes made during those years. But the hills have been continuously under personal observation, as they are a very important and exceedingly interesting subject of geologic study by the classes in the University.

With the constant excavation for sand and gravel many of the features noted below have been destroyed. In other parts of the range, where exploitation has ceased, the structure is now concealed by the slumping of the steep slopes, and by the growth of vegetation; while other and very interesting areas have been occupied for residences, or utilized for rubbish-dumps, instead of being included in the public park system, as should have been done.

The photographs here reproduced are the best description, and they will be the permanent record of the remarkable morainic phenomena.

Brighton Area

Plates 24–37

This division extends from Brighton village westward to the Cobbs Hill reservoir, including the knolls at the Steel reservoir of the Lake Ontario Water Company, and the forested part of the city park.

The eastern end has been deeply excavated for sand and gravel. and will eventually be filled and graded for building sites. Then the accompanying photographs will be the only record of very interesting glacial structures. With an abundance of building materials about the city, and with boundless area available in all directions for residences it would appear that an enlightened public policy would have preserved the hills with their glacial topography and commanding view, as part of the public park system, for the pleasure and education of later generations. By the geologist and the nature-lover this sort of real-estate "improvement" is described in uncomplimentary terms.

The most easterly excavation, and one of the oldest, was on the east side of Winton Road, now partly graded and filled. It was mostly coarse gravel, largely Medina sandstone, with great masses cemented by lime to stony hardness. The latter fact was probably one reason for the abandonment of the pit (plate 24).

The later and more interesting exposures are west of Winton Road. This area consisted of two ridges, similar to Cobbs Hill. The northern and main ridge, in direction west, 15 degrees south, connected with the high knolls in the north side of the wooded park, culminating at the steel reservoir. The Rochester sheet of the topographic map (figure 3) does not contour this area correctly. The lesser ridge, along the south side of the area, trends about southwest. Nunda Boulevard lies on its southern flank.

The large gravel pit in the east end of the area, close to Winton Road on the west side, the Sheehan pit, has for over 30 years been cutting back (southwestward) and giving excellent exposures with constantly changing detail of structures. This cutting has given us a cross-section in the heart of the east end of the range, with a vertical face of 30 to 50 feet. Plates 25–30 are from photographs of the face of this one excavation, and all taken on the same day They show the primitive and the induced structures, and the remarkable variation of the aqueo-glacial deposits, or the variable conditions during the depositional process, even within the short distances of a few score feet. The marks of tools, pick and shovel, should not be confused with the sand structures.

All the bedding here, beneath the till capping, is water-laid, sand and gravel, deposited in standing water under variable outflow from the near-by front of the ice-sheet. The fine-grained or silty layers represent the weaker flow, which could transport only the finest detritus. The coarser, sandy layers were deposited during more vigorous flow. Plate 31 shows the alternating coarse and fine layers when etched out by the wind. The sand layers are friable and are eroded by the wind, while the more compact and adhesive clayey layers resist the wind action.

This alternation of coarse and fine layers, very common in glacial deposits, certainly indicates some periodicity in the glacial outflow. The only periodic factor to which such thin layers can reasonably be attributed is the variation of flow between day and night. We may suppose that the weaker flow, with the lighter and silty burden, occurred late at night and in the morning, while melting of the glacier front was at the minimum; and that the copious flow, bearing sand and gravel, took place in the afternoon and evening when the melting was at maximum. This may give a time-gauge for such deposits of limited thickness.

The more southerly beds in the Sheehan pit, and the deeper beds in both this pit and the Elam pit on the west, were quite horizontal (plates 33–37). The north side of the pit generally showed considerable dip or southward slant (plates 29–30), which might be partly due to the original inclination, and partly to the up-tilting by the push of the readvancing ice-front.

At one place in the north side of the ridge a number of large blocks of limestone were imbedded in fine sand. Such anomalous

GRAVEL EXCAVATION SOUTH OF BRIGHTON
East side of Winton Road. Duffy pit. Looking southeast

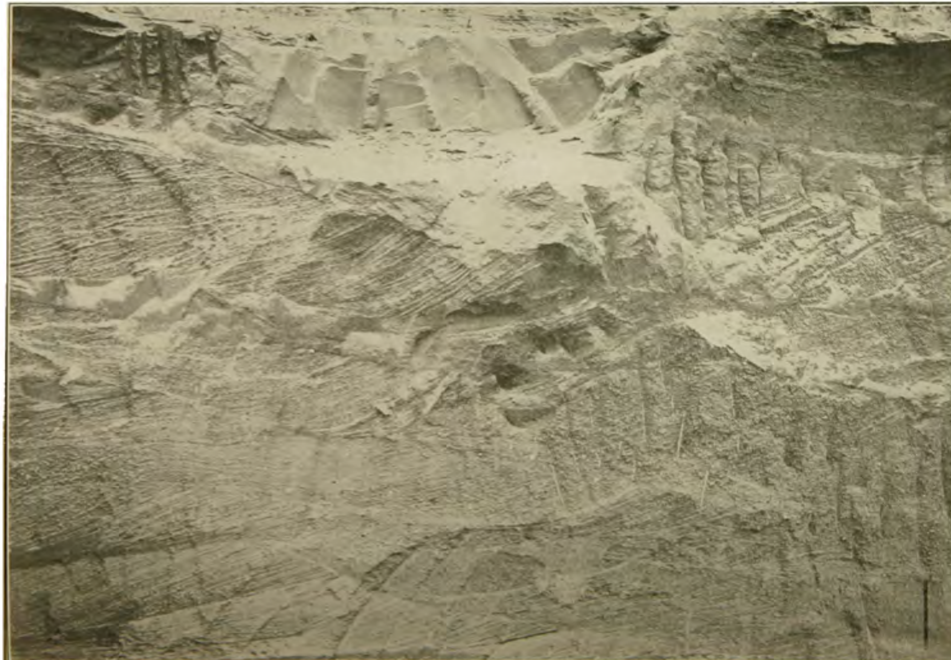
October 1894

BRIGHTON EXCAVATION
West side of Winton Road. Sheehan pit. Looking west 20 degrees south

October 17, 1894

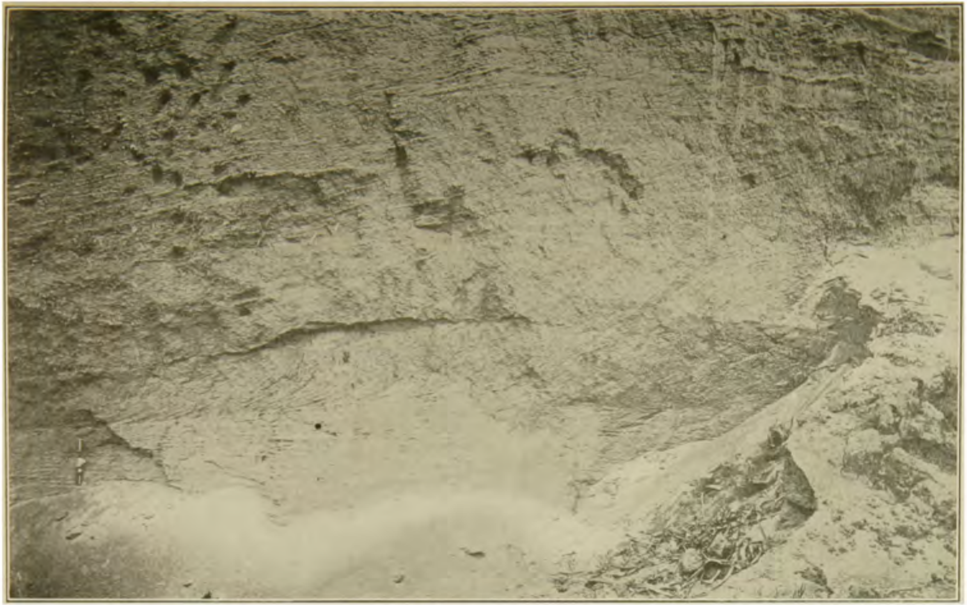
BRIGHTON EXCAVATION

October 17, 1894 West side of Winton Road. Sheehan pit. Near south end of pit. Looking west 15 degrees south



BRIGHTON EXCAVATION
West side of Winton Road. Sheehan pit. Looking west 10 degrees south

October 17, 1894

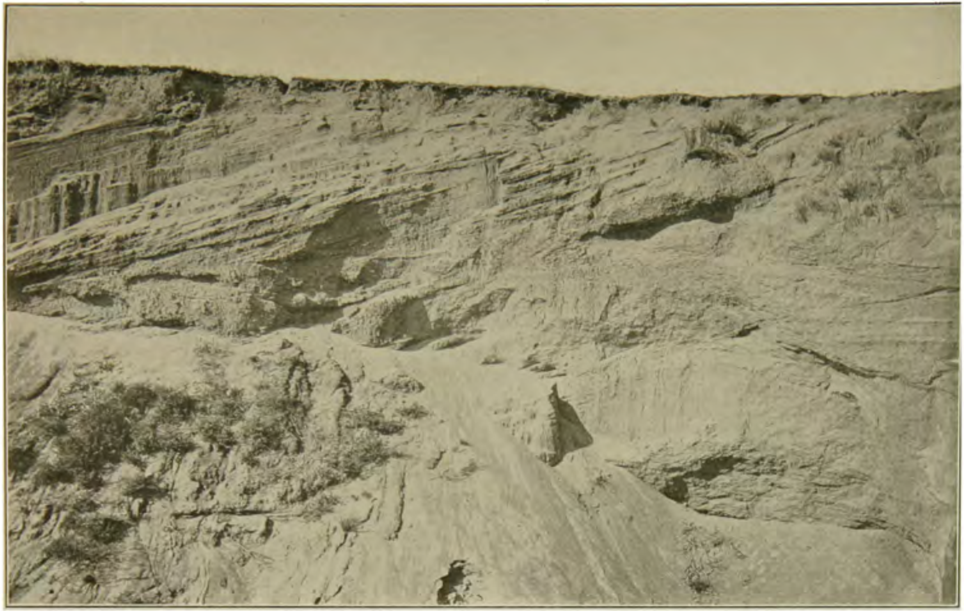


BRIGHTON EXCAVATION
West side of Winton Road. Sheehan pit. Looking west

October 17, 1894

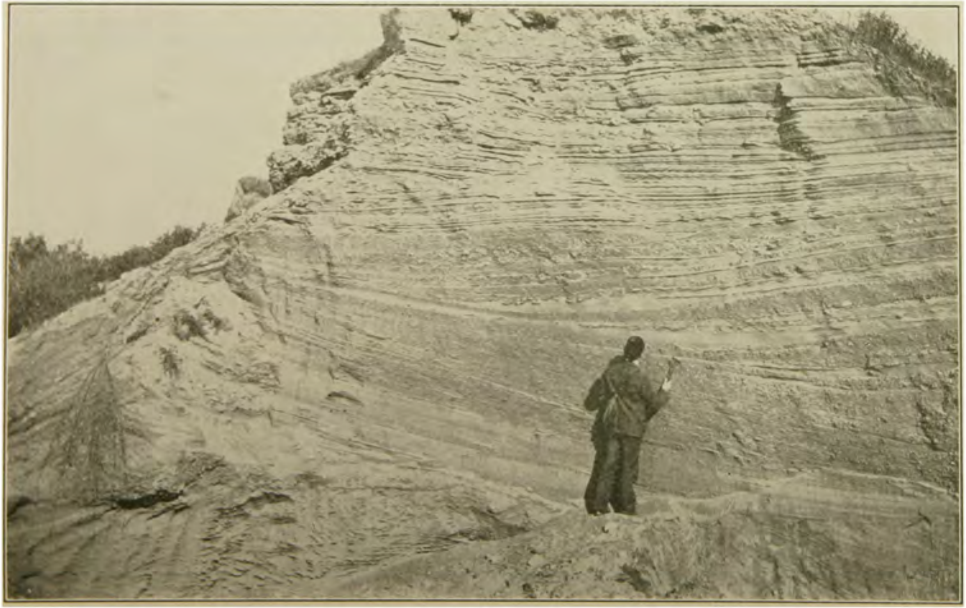
BRIGHTON EXCAVATION
West side of Winton Road. Sheehan pit. Looking west

October 17. 1894



BRIGHTON EXCAVATION
West side of Winton Road. Sheehan pit. Looking west

October 17, 1894



BRIGHTON EXCAVATION
Sheehan pit. Alternation of fine and coarse layers

October 21, 1901

BRIGHTON EXCAVATION
Showing crumpling and faulting. Sheehan pit.

October 21, 1901

BRIGHTON EXCAVATION

West side of Winton Road. Sheehan pit. Till capping. Looking west from Winton Road

November 11, 1917

TILL, CAPPING LAKE SAND

Small pit by Winton Road (Charles Elam) south of the Sheehan pit. Looking west. Compare plate 35

September 27, 1922

View looking west

Looking north at east end of cliff

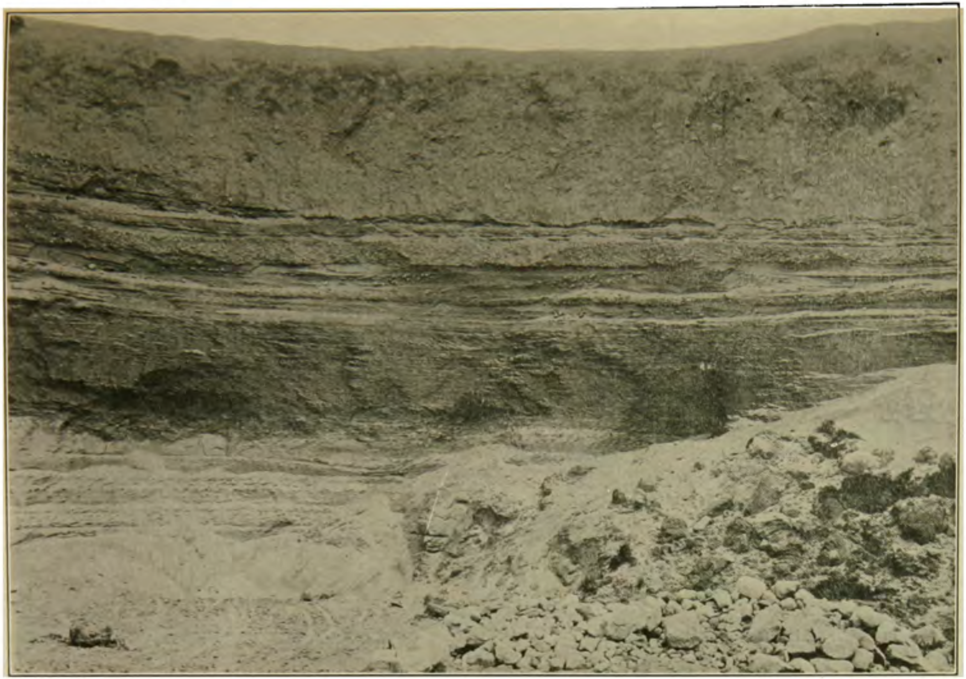
TILL, CAPPING LAKE SAND
Same excavation as in plate 34

October 1914

ELAM PIT, NORTH SIDE OF BRIGHTON HILL

West of Sheehan pit. Looking southeast. Compare later view, plate 37

October 15, 1894



WATER-LAID DEPOSIT CAPPED WITH TILL

Elam pit, north side of Brighton hill, west of the Sheehan pit. Looking east. Compare earlier stage, plate 36. November 15, 1918 relationship is impossible by water action alone. It is attributed to the rafting work of ice blocks, diminutive icebergs, detached from the ragged ice-front. Ice-rafted bowlders are not uncommon in fine-grained and stratified deposits laid in waters which bathed the fronts of glaciers, and they are regarded as proof of glaciation. They suggest, of course, sufficient depth of water to float the bowlder-weighted icebergs. Bowlders held in sand or gravel may be seen in plates 47, 65. In most excavations huge bowlders may be found which must have been imbedded in the excavated sands or gravels.

The horizontal water-laid beds in the Brighton area indicate lake water to at least the present height of 550 feet, while the western part of the range shows positive work of standing water to over 600 feet.

Many of the beds, especially the deeper ones in the Sheehan pit, (plates 26–28) show much discordance from the normal uniformity of quiet-water deposition. Some of this is probably due to variation during deposition in both the velocity and direction of flow. Irregular structure is to be expected in deposits laid at the margin of a rapidly changing ice-front. The common current ripples or flow-laminae show the direction of water flow. Here the general direction was southeastward or across the range. But the folded, crumpled, unconformed and faulted structures are certainly "induced," or formed subsequent to the deposition. Yet where such disturbed structures are local, and buried under undisturbed layers, as in plate 26, the disturbance must have occurred immediately after deposition, and may be attributed to the grounding and scraping and ploughing of floating ice-blocks, or little icebergs. These glacial-water structures have many curious forms, interesting but often inexplicable.

Much of the east end of the Brighton area is capped with massive till, 10 to 15 feet thick, seen in plates 33–37. In the early photographs of the Sheehan pit, and at the east end of the Elam pit at the present writing (1923) this was unstratified, gravelly sand. But in the center of the Elam pit (plates 36–37) and by Winton Road the topping bed is very stony and bowldery till. This cap of stony till was laid directly by the ice itself, and has already been noted as proof of the readvance of the ice-front, overriding, disturbing and burying the previous lake deposits.

The southeast slope of the Brighton area, as of the entire range in general, was laved by the lake waters, and probably somewhat eroded. This accounts for the smooth surface which grades off into the low plain, under 480 feet, the Dawson lake-bottom.

Passing westward along the north side of the range we find another pit, the old Elam pit, which forms the abrupt north side of the wooded park and of the Ontario Water Company's property. The material was coarse, bowldery gravel, with pronounced southerly dip.

The west end of the Brighton area is very fortunately preserved as city park, and left in natural forest. It contains a number of excellent kettles, and is a fine example of kame topography, or mound-and-basin structure; surpassed only by the Mt. Hope cemetery area. The south side of the forest tract is occupied by residences, known as Highland Heights.

The steel reservoir stands on the highest point of the Brighton area, with ground altitude of 620 feet. Very deep kettles lie both east and west of the reservoir. The north slope of the hills at this point is natural, and shows the steep and irregular surface produced by the ice-contact. The knolls here appear to be all gravel. The material was banked against the ragged ice-front, and when the latter melted away the gravel crumbled down to repose. The steep reentrants or hollows may have been somewhat deepened by later erosion. The kettles represent the places where detached ice masses were buried in the glacial outwash.

From the above description the reader will be able to prove the morainal origin of the deposits, and to interpret the history.

Cobbs Hill Area

Plates 38–52

This part of the Pinnacle range lies between the Brighton area and Monroe Avenue. It is now wholly occupied by the city reservoir and the surrounding park, and the geologic features are entirely obscured. Plate 44 is a general view from the west of the hill as it appeared in 1895, and plate 45 is a similar view of today.

Like the Brighton area the Cobbs Hill had two ridges, shown in plates 44, 46. The north and main ridge had trend west 15 degrees south, while the south crest was east and west. These ridges were morainal, composed of very bowldery till, especially the south ridge, as shown in plates 48, 49. The structures were revealed by an extensive excavation on the north side, near the Canal "widewaters," and the pits which encircled the west end, by Monroe Avenue. The original excavation was made in the cutting for the highway, Monroe Avenue, some time previous to 1838. Plate 47 shows the extension of this cut as it appeared in 1894. The many hundreds of bowlders show the stony character of the till at this point; yet Mr. Cobb said that these were only a part of the great numbers found. Most of the blocks were the local Niagara limestone; some of them with diameter to eight or ten feet. A few bowlders were Medina sandstone, and a very few were foreign or far-travelled. Excluding 25 larger blocks, it was estimated that the remainder would average two feet in diameter. Many bowlders were handsomely glaciated. All the excavations about the west end of the hill had been abandoned, evidently because of the very heavy capping of bowldery till, and because the lower beds were sand of texture too fine for use as building material. Yet in the condemnation for the reservoir the price was computed on the basis of good gravel.

The widewaters pit, on the north side of the hill, owned by Mr. Cobb, is now filled and buried under the retaining bank of the reservoir. In 1894, 60 to 80 feet of coarse material was exposed, with little if any original bedding preserved, except at the east end. Plates 38–40 show the beds dipping about 18 degrees from the horizontal, in direction somewhat west of south. The vertical section was as follows:

20 feet unstratified material, at the top.

15 feet coarse sand, grading into

10 feet of gravel.

40 feet of reddish sand, remarkably veined and faulted.

Throughout the pit there was much faulting and veining, with the veins cemented and lying in various directions. Medina sandstone formed the bulk of the sand and smaller cobbles. The larger bowlders were Niagara limestone, which is the case throughout the entire range. At the west end of the pit the whole depth was till-like and stony, while the top was true till.

Plate 43 shows a small pit east of the widewaters pit, opened in 1904 on the land of W. P Davis (whose residence appears in plate 44, on the south slope of the hill) to prove that his part of the hill was gravel. The contention was verified, for the enormous volume of gravel and coarse sand required for the concrete floor and walls of the reservoir was supplied, with much to spare, from the Davis end of the hill.

The steep dip of the beds shown in plates 40, 43 may not be wholly the initial dip or original slope. It may be due in part to sinkage on the south, and to the push from the north of the re-advancing ice-front. These views also show the rapid alternation of coarse and fine layers, representing periodicity in the deposition.

North of the widewaters pit and opposite the lock in the old Canal is a distinct moraine ridge, some 30 to 40 feet in height above the canal, with trend west 15 degrees south. This was a retreatal moraine built during a brief pause of the ice-front, in its removal northward. It probably correlates in time with similar moraine ridges west of Clinton Street, and west of Goodman Street.

Plates 51, 52, 54 show the Northrup pit, by Monroe Avenue, on the north side of the Cobbs Hill. At the east end of this excavation the material was unstratified, having been shoved and crushed by the ice. It held some bowlders, two of immense size. Westward this structureless mass was bounded by a nearly vertical fault, the whole thickness of about 30 feet lying against the fine sand which formed the walls of the remainder of the pit, as seen in plates 51, 52. Here a face of 60 to 70 feet of mostly fine reddish sand was exposed, with some lenses of sand and masses of till near the top. The downward curve, without much faulting, in the middle of the pit might be due to unequal settling, especially of unfrozen beds; or perhaps to the melting of buried ice. Probably great masses of morainal deposits were buried in a frozen and saturated condition. These sands were greatly faulted and veined. The veins had been channels for seepage, and being cemented by lime, they formed conspicuous projections on the crumbling walls. The largest vein was near the fault above noted, at the junction of the gravel on the east; the vein having nearly vertical position and with thickness of eight inches.

The old pit on the south side of Cobb's Hill, by Highland Avenue, had reached the crest of the south ridge, and showed a topping till of about 15 feet in thickness (plates 47–49). It appears that the south ridge was very stony till. Large blocks of limestone lay over the surface of the fields on the ridge, and in the hollow between the two ridges. Also piles of bowlders had been accumulated along the fences.

At the east end of this pit the lower beds were sand, quite horizontal and undisturbed, in contrast to the crushed and crumpled north side of the hill. Mr. Cobb said that ridges of sand originally extended away from the south slope, across what is now Highland

COBB'S HILL

North side of hill, near Erie canal widewaters. East end of pit. Looking southeast. Compare plates 39, 40.
October 15, 1894

COBB'S HILL

North side of hill, near Erie canal widewaters. East end of pit. Looking south 15 degrees east. Compare plates 38, 40
April 17, 1895

COBB'S HILL

North side of hill, near Erie canal widewaters. East end of pit. Looking southeast. Compare plates 38, 39

May 15, 1903

COBB'S HILL
North side. Top of pit by Erie canal widewaters. Looking west

May 15, 1903

COBB'S HILL
West end of pit near Erie canal widewaters. Looking south

May 15, 1903

DAVIS GRAVEL PIT

Northeast slope of "Cobb's Hill." (W. P. Davis pit.) Looking south 30 degrees east

October 15, 1904

COBB'S HILL
View looking east from Klinck knoll. Compare plate 45

April 18, 1895

COBB'S HILL
View looking east from flank of Klinck knoll. Compare plate 44

September 27, 1922

COBB'S HILL
North ridge. Looking northwest from the south ridge

May 16, 1903

COBB'S HILL

Old excavation by Monroe Avenue. Looking east, across the Avenue

November 22, 1894

COBB'S HILL

Old pit facing Highland Avenue. Looking northeast. Compare plate 49

April 17, 1895

COBB'S HILL

Old pit facing Highland Avenue. Looking north. Compare plate 48

October 19, 1899

COBB'S HILL
By Monroe Avenue, back of Toll-house

COBB'S HILL

North side, near Monroe Avenue. Old Northrup pit. Looking southwest. Compare plate 52

June 25, 1891

COBB'S HILL

North side, old Northrup pit, near Monroe Avenue. Looking southeast. Compare plate 51

May 15, 1903

OUTWASH PLAIN AND LAKE BOTTOM

View looking southwest from intersection of Monroe and Highland Avenues. The tract now called "Home Acres."
May 17, 1908

Avenue, toward the plain on the south. Also that patches and knolls of sand were found on the flat plain one-fourth to one-half mile away. These features had been removed in the grading for Highland Avenue and the long cultivation of the slopes and plain

The low plain south of the range carried a veneer of clay, streaked with sand, which for years supplied the brick factory on the extension of Monroe Avenue. The lake-bottom plain west of Monroe Avenue and south of Highland Avenue, now the Home Acres tract, is shown in plate 53.

The Pinnacle

Plates 54-60

This is the central area of the range of hills, and the culminating point in altitude. It includes the stretch between Monroe Avenue and South Clinton Street.

The east slope of the hill, facing Monroe Avenue, is now occupied by the Hillside Home (formerly the Rochester Orphan Asylum).

The northwest and west slopes, reaching to the apex of the hill, carry the old St. Patrick's (Catholic) Cemetery. Peck's History of Rochester states that it was established in 1838, and known as the "Pinnacle Burying Ground." In 1871 it was supplanted by the Holy Sepulcher Cemetery, on Lake Avenue, but, judging from dates on monuments, interments were made here as late as 1889. The main entrance on Pinnacle Avenue (now South Clinton Street) was left inaccessible by the cutting for the street, but the three stone columns of the gateway are yet in position, some 15 feet over the street, and appear in plate 62.

The "Pinnacle" has interesting relation to the scientific surveys of the region. As part of the geodetic surveys of the Great Lakes (1841–1881) the basin of Lake Ontario was surveyed by the Engineer Corps of the United States Army, and the Pinnacle was one of the stations for primary triangulation, occupied in 1875–1877.* The other stations of the district were Turks (Baker's Hill) south of Fairport, and Scottsville and Brockport on the west.

*Primary Triangulation of the U. S. Lake Survey; Professional Papers of the Corps of Engineers, U. S. Army, No. 24. Washington 1882.

The technical description of the Pinnacle station is found on page 515 of the report, as follows:

" in a Catholic Cemetery, on the summit of a hill known as Pinnacle Hill, about two miles southeast of the center of the city of Rochester. The geodetic point is marked by a cross and the letters U. S. cut in a bowlder 3 feet below the surface, with an ordinary marking stone set directly over it, rising to the surface of the ground. Two stone reference posts are set as follows: one bearing north 15° 23′ west, distant 22.56 meters, and one bearing south 13° 12′ east, distant 31.73 meters from the geodetic point. A large marble monument marked Mahon on the base, bears S. 80° 55′ W., distant 87.97 meters, and a large granite monument, with Cummings on the base bears S. 70° 26′ W., distant 117.75 meters A black oak tree bears N. 82° W., distant 25.54 meters.

The height of the ground is given as 502.1 feet over Lake Ontario, which makes the altitude 748.7 feet above tide. A square tower, 33 feet high, was erected on the hill, and the four holes for the corner posts are yet conspicuous, with a depression over the geodetic point. When the U. S. Geological Survey made the topographic survey for the Rochester quadrangle, in 1893–1894, the Pinnacle station was reoccupied for the secondary triangulation. Close south of the tower site is a smooth level space which was the site of the house used by the engineers.

On the northeast slope of the hill is a conspicuous bald knob, known as Klinck knoll, (690 feet) which is a favorite view point. Blocks of Niagara limestone are imbedded in the top. An excavation, plate 56, lies in the hollow south of the Klinck knoll, opened more than 30 years ago, and abandoned probably because it revealed only gravelly and stony till. The material is largely waterworn, Medina sandstone predominating. The cobbles include many crystallines and some of the bowlders are granitoid and quartzite.

The north slope of the Pinnacle is very irregular, with gullies and knobs, partly due to the ice-contact and partly to late deposition by the ice edge. Some old diggings above the street named Pinnacle Road show ice-laid stuff or till, crowded with unworn blocks of Niagara limestone up to six feet in diameter. Such sand and gravel masses as appear have been mashed in the till.

Climbing the Pinnacle from the Hillside Home, the path up the steep east slope shows angular bowlders in the massive gravels. On the very crest of the Pinnacle are huge blocks of Niagara limestone imbedded in the deposit. The occurrence of these blocks at such

THE PINNACLE

View from Northrup pit, looking west toward the Pinnacle

May 15, 1903

THE PINNACLE

View from the Cobb's Hill reservoir. Looking south of west. Compare plate 54

September 27, 1922

THE PINNACLE
Old pit on east slope, south of Klinck knoll. Looking southwest

November 22, 1894

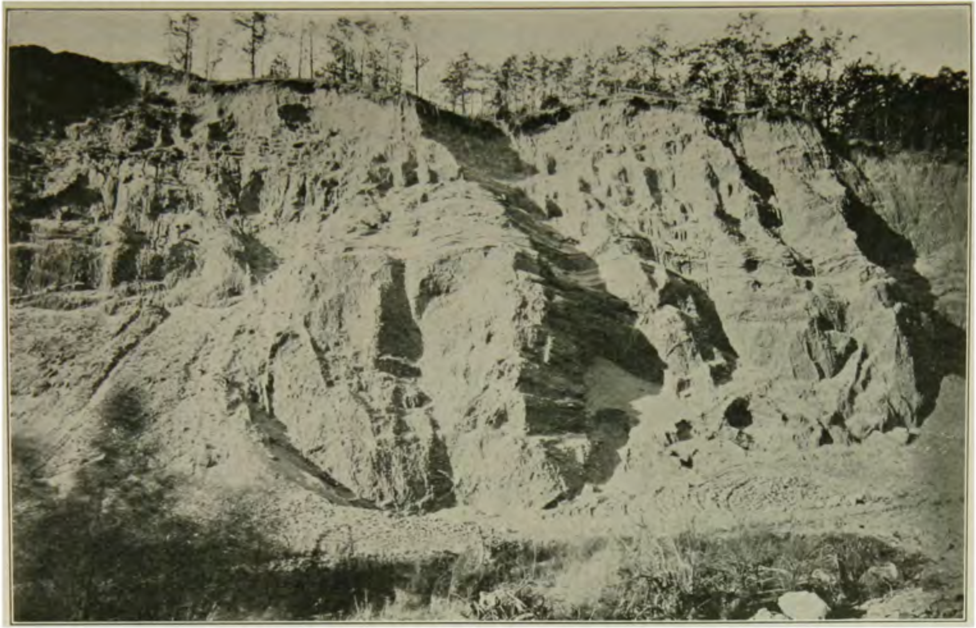
THE PINNACLE

Excavation (Schwalbach) on southwest slope. Looking northeast

April 18, 1895

THE PINNACLE
Middle of Schwalbach pit. Looking north

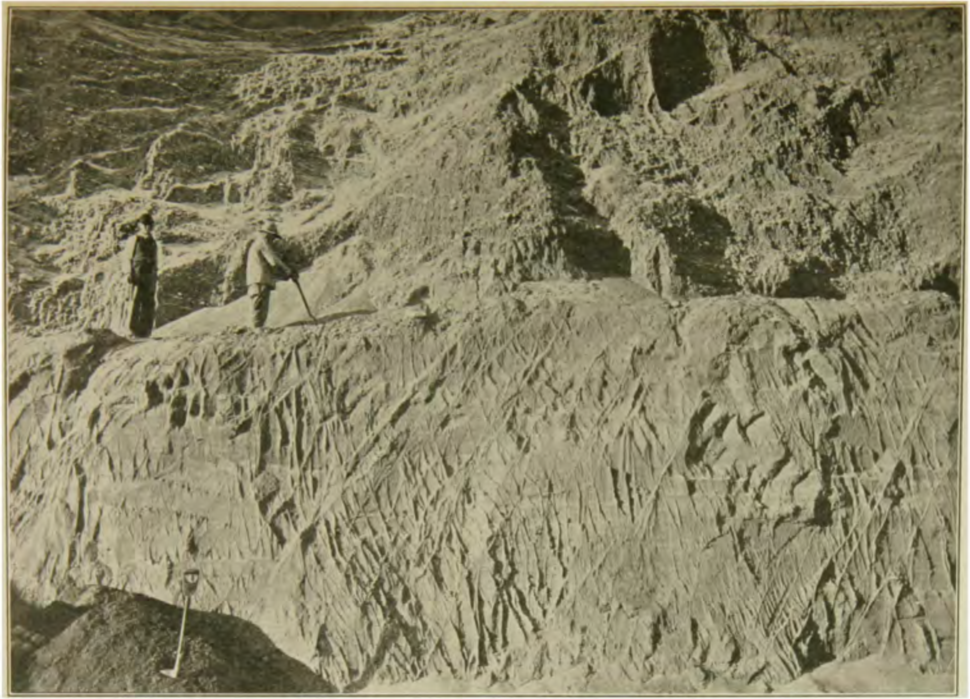
April 18, 1895



THE PINNACLE

Schwalbach pit, southwest slope of hill. Looking north. Compare plate 58

October 17, 1894



THE PINNACLE

Schwalbach pit, southwest slope of hill. Minute faults in fine gravel

October 17, 1894

height suggests interesting questions relating to the mechanics of glacier work. The northern outcrop of the Niagara (Lockport) limestone lies through the center of the city. The limestone blocks must have been plucked from their original positions by the bottom ice. Hence within a maximum distance of about two miles the ice sheet lifted the bowlders about 275 feet (460–480 feet up to 749 feet). It is inferred that the relatively thin edge of the plastic ice sheet, charged with its rock burden, was pushed up the north slope of its own morainic deposit by the impulse of the thicker ice on the north, perhaps assisted by the buoyant effect of the lake waters.

One of the largest excavations in the entire range, and the one with the highest face, is the Schwalbach pit on the southwest side of the hill, shown in plates 57–60. The exposure was over 100 feet in height. In recent years this pit is abandoned and the crumbling walls have buried the interesting glacial records, partially preserved in the old photographs.

This excavation encroached on the cemetery, and at one time the irreverent work exposed the contents of neglected graves. Unlike modern exploration and desecration of Egyptian and other ancient tombs this could not be excused as in the interest of history and archeology. The top of the slumping bank of the excavation is now (1923) about 734 feet elevation.

Like other exposures in the range the materials here were varied and changed character as the excavation extended. The upper portion, perhaps one-third of the vertical face, showed no bedding but was tumultuous, apparently crushed by the advancing and overriding ice sheet. Below this the bedding was clear, but in some places exceedingly faulted and veined, as shown in plate 60. Some masses were firmly cemented. There was a general dip of the beds 10 to 15 degrees in direction southeast, or even eastward. In the center of the pit a stratum of fine sand, much distorted, about 15 feet thick, lay beneath the non-bedded upper deposit. This stratum shows in plates 58, 59. It declined eastward about 50 feet in a distance of 400 feet.

Few bowlders occurred in this pit, but two large Medina blocks were noted and several granitic bowlders. A count of the pebbles made by the students showed that up to egg size 50 per cent were Medina, and above that size about 35 per cent. Near Clinton Street uptilted strata and remarkable sand concretions occur (plate 65).

The Schwalbach pit has deeply cut the south slope of the hill westward to, and beyond, South Clinton Street, which street is here made the limit of the Pinnacle area.

Along Highland Avenue, south of the Pinnacle, and near the east end of the great Schwalbach pit, cutting has been made in the south side of the range, on lands of J. L. Schrader, C. A. Schrader and Frank Crouch. The exposure here is heavy, gravelly till at the top, with many stones, and very large bowlders (plates 65, 77). Below are gravels which grade down into sand. This is one of the two localities where till has been found on the south side of the range.

On the west slope of the Pinnacle four terraces, or benches, are seen. The highest one carries the Cummings burial plot and monument referred to in the description by the U. S. Lake Survey engineers. The elevation is about 725 feet, which corresponds to the summit plane of Lake Dana on this parallel. It is possible that this small terrace is artificial.

A larger terrace is probably natural. A level space, some 50 feet wide and 150 feet across the ridge, has elevation about 700 feet. At the east end this carries a drive and the enclosed Hughes burial plot. The steep bank on the east has the appearance of a wave-eroded cliff. Toward the west end of the larger terrace the enclosed burial plot of Brennan is about three feet higher, and the original surface there is about six feet over the smooth lower area next to the cliff.

A lower bench of rolling surface, at about 660 feet, carries the monuments of John McCambridge and Bernard Lennon.

The lowest and strongest terrace is quite certainly natural, with elevation about 648 feet. It is about 50 by 250 feet in area, covering the top of the ridge, near Clinton Street, and carries a number of plots, the tall Cochrane monument standing at the east end. The old drive entering from Clinton (old Pinnacle Avenue) curves around the east end of this terrace. This terrace is the same elevation as the level-topped ridge west of Clinton Street.

Clinton Street and the Lowland Westward

Plates 61–67

The natural geographic division between the Pinnacle mass and the Highland Park area is the sag in the range, half-way between

Clinton and Goodman Streets. But the lowland, with some special features, is included, for description with the Clinton Street area.

At Clinton Street, S. the main ridge has been deeply excavated by westward extension of the Schwalbach cutting, as shown in the photographs, and some work is yet in progress (plate 61).

Here the material is mostly sand, and much of it so fine or with so much silt that the excavation has been irregular. Cementation of the sand, by deposition of lime, has also interfered with the work.

All of the original bedding here has been disturbed, and much of it has been obliterated. Some sections show much faulting, with production of interesting reticulated structure (plates 64, 60, 32). Probably the movements which produced these structures occurred when the sands were solid by freezing. Plate 65 shows a spire close to the street in which the sand strata have nearly vertical position. At the time of writing (April, 1923) this locality is the best exposure in the range for the study of disturbed and distortion structures.

Relatively few bowlders are seen in the Clinton Street cuttings, but they do occur, and several are noted in position, imbedded in sand at both high and low levels. (Plate 65.) Some gravel appears in plate 63, but the masses in plate 64 are only firm blocks of the partially cemented and reticulated silty sand. Considerable color is noted here, greenish, yellowish and pink layers. Some of the reddish and clayey sand is indurated into "stone."

As elsewhere in the range the lowest exposed beds are stratified sand. East of Clinton Street, perhaps one-eighth of a mile, in the bottom of the old Schwalbach pit, where perhaps 100 feet of overlying gravel has been removed, 15 feet of clean, fine sand is exposed in an active operation. The elevation at the bottom is about 580 feet, somewhat below the summit of the street.

West of Clinton Street the remnant of the main ridge has a level crest, at about 648 feet; the same height as the lower, strong terrace east of the street in the cemetery.

North of the main ridge, and west of the street, is a minor, very stony morainic ridge, which carries a small cemetery, the St. Boniface Church Cemetery. Between this later ridge and the main ridge is a deep sand excavation, now partly filled and leveled for a baseball ground. It had reached perhaps 30 feet below the street, with the face of the pit rising 40 feet, more or less, above the street. No original bedding was shown here. A new street, Highland

Parkway, in line with Field Street, is planned to occupy the hollow between the ridges.

The decided sag or depression in the range between Clinton and Goodman Streets represents deficiency in the moraine building; and this has been increased by the production of kettles, due to the melting away of ice-blocks which had been more or less buried in the drift deposits. Three large and handsome kettles lay here, two of which are shown in plates 66, 67. The one with the geology class "in a hole" was in the very axis of the range and at the lowest point in the sag.

Another large kettle, and scientifically the most interesting of the three, was situated between the two basins noted above. It lay in a deep embayment in the north side of the high ridge, and was known as the "peat-bog kettle," and was described in a paper, number 9 of the appended list of writings.

This kettle had evidently been a deep lakelet but had become filled with decomposed vegetal matter, or peat, by the drifting in of forest materials and by the growth of swamp vegetation. In wet seasons the marsh was wet, but in the summer it was dry. The level floor of the basin, oval in form and about 140 by 300 feet in dimensions, was occupied by a growth of yellow birch which had developed "knees" so as to lift the trunks above the water. The peat was used by Ellwanger & Barry, who owned the area, for packing the roots of nursery stock for shipment, and it was probed to a depth of 25 feet.

The presence of standing water in these kettles for considerable part of the year implies an impervious bottom, but whether till or rock is unknown. Directly north of the peat bog was another small kettle with a wet-weather lakelet.

All of these beautiful topographic features, of scenic and scientific interest, have been destroyed. The kettle shown in plate 66, with adjacent basins, has been made a city dumping-ground for ashes and rubbish, and the peat-bog kettle is suffering the same shameful fate. The charming lakelet, plate 67, lay only a short distance east of Goodman Street, and is now obliterated by real estate development. It has been filled and the site traversed by a new street lying south of Rockingham Street, the Highland Parkway.

SECTION AT SOUTH CLINTON STREET

View from west slope of the Pinnacle, looking west. Extension of the Schwalbach working

April 18, 1895

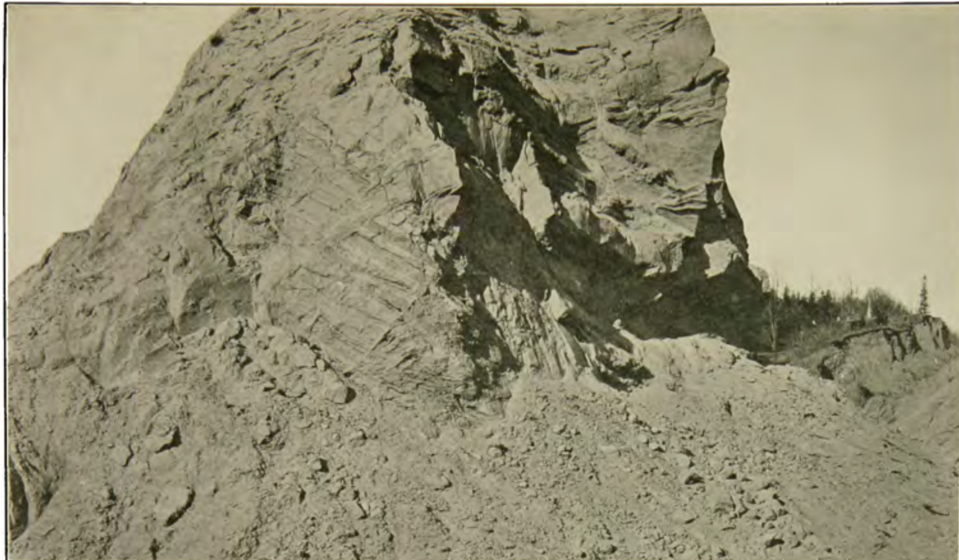
SECTION AT SOUTH CLINTON STREET

View looking north of east, toward the Pinnacle. Clinton street crosses the picture, left to right

October 17, 1894

SECTION AT SOUTH CLINTON STREET
Excavation west of the street. Looking southeast. Sands highly crumpled

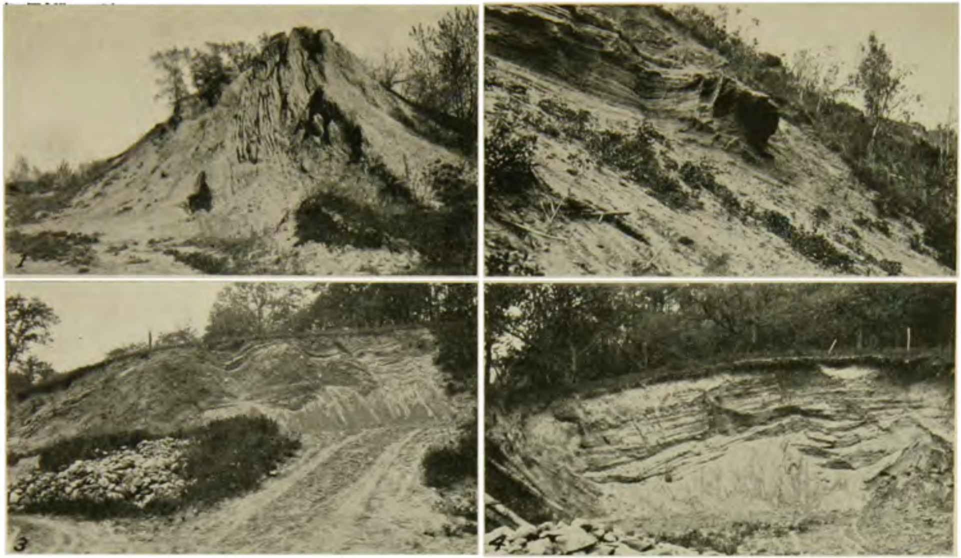
April 18, 1895



SECTION AT SOUTH CLINTON STREET

Rectangular structure produced by complex fautling, in sandy silt

April 18, 1895



STRUCTURES ON THE SOUTH SLOPE OF THE PINNACLE

1. Upturned beds of fine sand, east side of Clinton Street. Looking southeast
2. Indurated (lime-cemented) sand, east of Clinton Street. Looking northeast
3. Contorted gravel beds, south of the Pinnacle. In the Schrader pit. Looking west
4. Gravel beds back of No. 3. Looking north

LOWLAND WEST OF CLINTON STREET
Kettle in low point of the range. Looking north

May 16, 1895

KETTLE-LAKE EAST OF SOUTH GOODMAN STREET
View looking north of east. The Pinnacle in the distance

April 18, 1895

South Goodman Street Section

Plates 68-72

In the year 1894 South Goodman Street was extended across the Pinnacle range by a cutting over 40 feet deep. And our information reaches deeper, because at the same time a large sewer, connecting the County buildings on Mt. Hope Avenue, was constructed in a tunnel 35 feet below the present summit of the highway. The City Engineer's elevations are as follows:

Original crest of the ridge	623.24	feet
High point in the street	580.94	"
Elevation of sewer	545.84	"
Depth of sewer below street	35.10	"

The entire exposed section was in sand, and the tunnel was wholly in fine, reddish sand. The tunnel contractor stated that five large bowlders were encountered. The smaller ones, 150 to 200 pounds, were found in the course of the trunnel, but the largest, about one ton in weight, lay over the tunnel and fell in. The presence of bowlders in fine, bedded sand proves a rafting process, and here it implies the work of floating ice-blocks or miniature icebergs, detached from the rough ice-front, which was faced by lake waters of some depth.

Through the south slope of the ridge the sewer excavation was an open cut, showing the same fine, reddish sand with some clay layers; and near the top some thin layers of fine gravel. The top and south slope of the ridge showed red Medina gravel, collected by the removal of the sand by wind erosion.

A smaller ridge south of the main ridge was trenched for a conduit leading to the Mt. Hope Reservoir, ascending the ridge obliquely, and which revealed mainly fine sand, with thin streaks of gravel and frequent bowlders. At a later date a pit on the south side of the south ridge, on the west side of the street and near Highland Avenue, showed distinctly bedded sand and gravel in thin and rapid alternations. Many angular stones and glaciated blocks were scattered through the deposit, with some till-like masses. The latter could have been dropped in a frozen state. No faulting or other disturbance was observed here. Opposite this pit and on the east side of the roadway the material appeared as true till, heavy and compact, with angular and striated stones.

These details are given to emphasize the varied composition of the moraine and the fickle character of the geologic agents. The remarkable cross-bedding and erosion structures shown in plate 71 indicate a history, or succession of deposition and erosion, which challenge any attempt at translation.

Between the main ridge and the smaller one on the south some large granite bowlders lay on the surface, and a few others were seen in the nursery on the main ridge east of the street.

This Goodman Street section is remarkable for the great depth and breadth, practically the entire range, of bedded sand, the gravel being insignificant. This section is in striking contrast with the coarse material of the Pinnacle, only three-fourths of a mile away. The sand was too fine for concrete. Much of it was so silty and adhesive that it resisted removal by the wind. The structure and flow-laminae, and the periodic variation in conditions of deposition, were elegantly revealed by the autumn winds (plates 69–72). The general direction of water-flow, as shown by the ripples, was south 15 degrees west.

Some very conspicuous and handsome faults are shown in plates 69, 70. The two faults in plate 70, on the east side of the cut, become broken into compound faulting on the other side of the cut, as shown in plate 69.

North of the main ridge at Goodman Street is a lesser but strong ridge, from which the picture in plate 68 was taken. This morainic ridge extends west to the Highland Hospital. It is separated from the main ridge by a distinct hollow, perhaps 300 feet across. The grading for the street cut about 15 feet, vertically, into this till ridge, and the sewer trench, 14 feet deep, showed six feet of till beneath which was sand of unknown depth, as in the main ridge. Two square pits for sewer inlets excavated seven feet below the curb gave good sections of the lowest till. The complete section of the pit at the east curb is as follows:

A. Surface of ridge, yellow sand.

B. Reddish till, 10 to 15 feet.

C. Brick-red till, two feet. Containing angular stones of limestone and crystallines. The lower limit sharply defined.

D. Yellow till, 18 inches. Streaked with thin sand layers, and holding Medina and limestone pebbles. Reddish at bottom.

E. Red, laminated clay. Crumpled and distorted. About one inch.

SOUTH GOODMAN STREET SECTION

Cutting for street extension. View looking south

September 27, 1894

SOUTH GOODMAN STREET SECTION

Faulting in sand strata. Compare plate 70. Looking northwest

November 18, 1894

SOUTH GOODMAN STREET SECTION

Double fault in sand beds. Compare plate 69. Looking east

November 18, 1894

SOUTH GOODMAN STREET SECTION
South end of cut; looking east. Erosion and unconformity in fine sand

November 18, 1894

SOUTH GOODMAN STREET SECTION

Alternation of coarse and fine sand layers. Looking northwest

November 18, 1894

F. Gray till, 20 inches. With no stratification; some gravel, and few pebbles.

G. Fine sand, for at least seven feet. Clean, sharp, well stratified, with some gravel.

This is a record of at least seven changes in the process of deposition. The thick basal sand indicates open water. The overlying till represents overriding by the ice-sheet, with considerable variation in its action.

West of Goodman Street a great excavation between the Highland Park mass and this northern ridge has exposed a section of the latter where it is much higher than at Goodman Street. Here 10–15 feet of till caps the sands and gravel. (See next chapter.)

This northern moraine ridge appears to represent the latest pause of the thin ice-front before it made its final and more rapid retreat. It correlates with the St. Boniface Church Cemetery ridge, west of Clinton Street; and with the till ridge by the "eastern wide-waters" (now converted into a public skating rink).

Highland Park Area

Plates 73–76

This area extends from South Goodman Street west to Mt. Hope Avenue, being bisected by South Avenue. Excepting a large excavation, by Ellwanger & Barry, on the north slope, it is fortunately preserved as city park or residential tracts. The surfaces have been somewhat modified, but not sufficiently to destroy its morainic aspect.

The eastern portion, between Goodman Street and South Avenue, consists of two ridges, like the Brighton and Cobb Hill areas. But here the ridges are larger, more distinctly separated, and of higher relief. The intervening hollow is 50 feet or more in depth, and the knolls rise 120 feet over the Rochester plain. The south ridge carries the Memorial Pavilion and the Mt. Hope Reservoir. The main park driveway between South Avenue and Goodman Street lies in the hollow between the ridges. Plates 73, 74 show this depression as it was in 1894; but the grading and artificializing has somewhat changed the appearance.

The largest kettle in the area is close to South Avenue on the west, in the northeast corner of the city property west of the avenue, in what was the "Warner tract." The swampy bottom is now an artificial pond, surrounded by pleasure and tennis grounds.

The till ridge on the north, mentioned in the preceding chapter, appears in plate 74. Plates 75, 76 were photographs of the large excavation north of the main ridge as it was in 1895. It then showed a vertical face of nearly 100 feet, with the usual variation of sand and gravel, with the structures due to original deposition and the subsequent disturbances by the ice push. The excavation had reached into the minor till ridge on the north, and showed about 15 feet of till capping. One huge block of Niagara limestone was seen beneath the till, and many smaller bowlders. This excavation is now (1923) in use for making cement block, and some of the structures may be seen. A deeper pit in the east end of the large excavation showed clean fine sand, as might be expected so near to Goodman Street, with the layers slanting in different directions.

Trenches for water mains in connection with the reservoir revealed variations in the water-laid materials and their structure, which would be tedious to describe.

The cutting for South Avenue showed two or three feet of fine, yellow sand, so frequently found as the surface deposit. Beneath this was 15 feet of pinkish or yellow sandy till, or what might be called a stony sand.

It may be noted that the north-and-south line across Highland Park area shows three distinct moraine ridges.

Mt. Hope Cemetery Area

This area extends from Mt. Hope Avenue west to the Genesee River and to the cut across the moraine for the Erie and the Lehigh Valley railroads. The northern part of the area, which is the older portion of the cemetery, is an unsurpassed example of kame topography. The knob-and-basin forms give high and sharp relief. Deep kettles lie among tall, steep-sided, conical gravel mounds, producing an unusual land surface. It is very difficult to obtain satisfactory photographs of the kettle-basins, but the failure here to include pictures is not serious, because the features are preserved and open to easy observation.

Where so much of sentiment and reverence are demanded of the visitor to this most beautiful of cemeteries the natural geologic features may be unnoticed or unappreciated. But it will not de-

HIGHLAND PARK AREA
View looking southeast

September 1894

HIGHLAND PARK AREA
View looking northeast from near gatehouse of reservoir

April 20, 1895

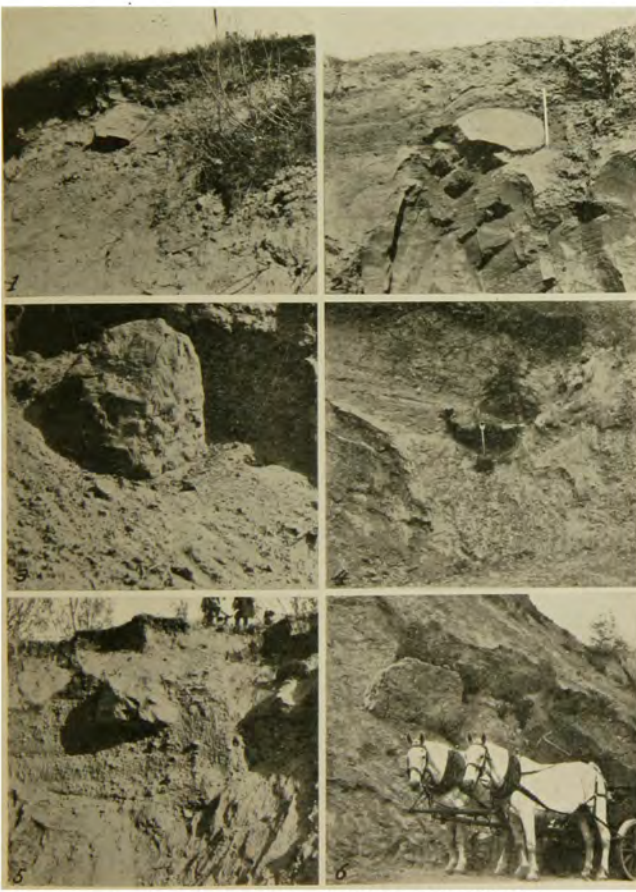
HIGHLAND PARK AREA

Excavation (Ellwanger & Barry) north of park. Looking south of east, toward the Pinnacle, from the northern moraine ridge April 20, 1895

HIGHLAND PARK AREA

Ellwanger & Barry pit, east end. Looking south of east. Compare plate 75

April 20, 1895



ICE-RAFTED BOWLDERS IN WATER-LAID DEPOSITS

1–3. In sands east of Clinton Street S. 4–6. In gravels south of the Pinnacle
From over No. 2, a granite bowlder, 80 feet of gravel have been removed

tract from the honor due the departed for the visitor to realize that they repose in the midst of the finest display, in a small area, of the singular earth-forms produced during a romantic episode of the geologic history of the Rochester region.

The drive called Indian Trail leads around over the higher ground, among the higher knolls and deeper basins. The four kettles which have not been greatly altered lie in the area circled by the Indian Trail and Dell Avenue. The two larger basins are the one holding the pond, called Sylvan Water, and the one on the west side of Dell Avenue, which formerly held a water tower. Three basins have been partially filled. Elevations are given in a later chapter.

The only other part of the Pinnacle range which is comparable with Mt. Hope for kame-and-kettle structure is the eastern part of Cobbs Hill Reservoir Park, and about the steel reservoir.

The composition of the knolls is mostly gravel, or gravelly sand, becoming finer southward. Many years ago a tunnel for drainage was run from the swampy basin near the main entrance westward toward the river, which is reported to have encountered chiefly sand.

The newer part of the cemetery includes the smooth plateau-ridge, which carries the Firemen's and Soldiers' monuments, having elevation about 585 feet. The railroad cut across this ridge exposes some 30–35 feet of sandy till, or of sand charged with stones and limestone bowlders. The southward slope of the ridge declines to the clay plain at Elmwood Avenue.

The highest knob in the cemetery is at the east side, near Mt. Hope Avenue, with elevation about 676 feet. The bottom of the deep kettles is about 605–610 feet elevation. The altitude of the ridge at the railroad cut is about 585 feet. The contouring on the Rochester sheet of the cemetery area, as well as all the Pinnacle range, is unreliable for detail.

The cemetery area is the widest part of the entire range, being about three-fourths of a mile, from McLean Street on the north to near Elmwood Avenue on the south. But north of McLean Street, and lying between Mt. Hope Avenue and the Harbor Boulevard, is a high knoll and gravel ridge extending northward, with declining elevation, to near Clarissa Street. An old excavation on the river side exposes bedded sand up to 40 or 50 feet above the river plain. Regarding this mass as a part of the moraine gives a total width of the Cemetery area of about one mile.

Oak Hill; University of Rochester Site

This area is the westward extension of the ridge in the west side of Mt. Hope Cemetery. The cut for the railroads makes the artificial division. The area lies in a meander or sharp westward bend of the Genesee River, which is the reflex of the eastward meander in Genesee Valley Park.

Doubtless the moraine extended as a continuous ridge westward from the cemetery kames to and along Brooks Avenue, west of the river. The river has breached the moraine, and the Oak Hill area lies between the artificial railroad cut and the natural river trench.

The surface of Oak Hill has been somewhat smoothed, for the golf ground and the drives, but it yet shows the rolling morainal surface. The altitude is somewhat under the cemetery ridge. The highest point is close to the railroad cut, being 584 feet. The central ridge has elevation by the railroad cut of 580 feet, declining westward to 565 feet at the Club House.

The Moraine as River Barrier: the Scottsville Lake

The relation of valley, river and moraine indicates that the latter must have been, at a late stage in the history, a barrier to the river. The reader will recall that the moraine was built in the waters of Lake Dana, or the sub-Dana. Eventually this lake was drained down, by eastward escape toward the Mohawk-Hudson, so that the moraine at Oak Hill appeared above the water surface. Then the waters south of the moraine and west of the South Avenue (West Brighton-Ridgeland) ridge must have been a shallow, local, morainal lake, with outlet northward, across the ridge where the river has made its cutting. Of course this point of original overflow must have been the lowest point on the crest of the ridge which the waters touched. Judging by the map contours, the altitude of the original overflow could not have been much over 540 feet (present elevation), or the river would have made its cut somewhere on the west, across the line of Brooks Avenue. With an initial elevation of 540 feet the lake waters would have extended far south up the valley past Scottsville toward Avon. We may name the waters the Scottsville Lake.*

Lake Dana was connected eastward through the pass at Victor, where the eroded channel has elevation of 600 feet. Recognizing the differential land uplift of about two feet per mile, the plane of the Victor pass, and the lowest Dana waters in this district, is about 620 feet. Consequently, when the waters were lowered below 620 feet at Rochester and Fairport they could escape only through the Fairport valley. They then ceased to be Lake Dana and became Hyper-Dawson. It follows that the establishment of the Scottsville Lake was after the Hyper-Dawson waters had fallen about 80 feet (620–540).

The overflow of the Scottsville Lake was into the subsiding Hyper-Dawson waters north of the moraine. As the latter lake eroded the drift-filling east of Fairport and lowered its level at Rochester, the Scottsville Lake outlet (we may not as yet call it Genesee River) was encouraged to correspondingly erode its channel across the moraine, thus lowering the lake level.

During the life of the Scottsville Lake it was a catchment basin for the detritus brought down by the Genesee River, and the broad valley plains from Rochester to Avon are partly the lake sediments, topped by the silts left by the river floods.

When the river in its downcutting found the limestone rock at the "Rapids," at about 500 feet elevation, its rapid cutting ended.

The outflow of the Scottsville Lake into Lake Dawson could not build any heavy delta deposits in the latter waters, because the Scottsville Lake was holding the sediment of the upper river; and the detritus for delta building was only that supplied by the erosion of the outlet channel across the moraine.

The theoretic succession of deposits in the Genesee Valley above the moraine are as follows, numbering from the bottom upward:

1. Any Preglacial materials which the ice sheet did not brush away.

2. Glacial drift; till, bowlders, gravel.

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*These waters were recognized in 1895, in a paper on "Glacial Genesee Lakes," Bull. Geol. Soc. Amer., Vol. 7, 1896, pp. 445 and 450. The name "Scottsville" was used in 1907, in N. Y. State Museum Bulletin, No. 118, page 81.

3. Glacial lake sediments, in lakes Warren and Dana. Partly from the glacial outwash and partly by the Genesee River.

4. Accumulation in the shallow Scottsville Lake.

5. Floodplain silt from the overflow of the present river.

The rolling plain between Elmwood Avenue and Crittenden Boulevard, occupied by the University of Rochester Medical College and Hospitals, illustrates the Scottsville Lake deposits. In examination of the area with reference to foundations for the buildings, nineteen test holes, by wash-boring, were distributed over the tract of about four acres. These borings gave an average depth to "rock or bowlders" of about 34 feet; the shallowest hole being 26.6 feet, and the deepest 49.0 feet. The greater depth was along the east side of the tract, which has a surface elevation of 540–545 feet.

The most definite and uniform stratum found by the exploration is the surficial deposit of fine, sandy, pinkish-yellow silt, called "yellow clay" by the drillers. This averages 8.4 feet in thickness, with a minimum of 6 feet and maximum of 9.6 feet. Beneath the yellow silt is a variable deposit of chocolate-colored or purplish clay and silt, called by the drillers "brown clay and sand." This varies in thickness from seven to 25 feet, with average about 15 feet, the greater thickness being on the east side of the area. This stratum is highly calcareous, and appears to be chiefly the rock-flour of the glacial mill, swept into the lake by the glacial outwash. Large bowlders were encountered in the clays.

Beneath the dominant deposit of clay is coarse material, sand, gravel and bowlders. The borings did not discriminate the water-laid material from the till or ice-laid material.

When the borings were made, in the winter of 1922–23, groundwater was reached at 15–17 feet from the surface of the plain, beneath which the fine materials behaved as "quicksand," necessitating that the buildings be set on concrete-pile foundations.

It will be seen that the succession and the character of the deposits agree with the theoretic succession for Lake Scottsville beds, as noted above. The coarse bottom stuff represents the glacial drift, along with the coarser stream outwash dropped close to the receding edge of the submerged ice. The thick brownish clay and silt is the finer material of the glacial outwash, carried out into the lake by the gentle currents, and in suspension, while the coarser sand and gravel were building the moraine of Mt.

Hope Cemetery and Oak Hill. The topping yellow silts are too thick to be attributed to the post-lacustrine oxidation and weathering, and must be referred to the river-borne sediments dropped in the shallow lake waters during the closing phase. This river detritus had been long exposed to atmospheric agencies previous to the time of its final deposition.

Elevations on the Range

All the figures for altitudes given in this paper refer to mean ocean level, and are based on the figures of the Barge Canal Survey. The local reference bench mark (B. M.) in Rochester is a bolt set in the coping of the old canal aqueduct, at the curve east of Exchange Street. The elevation of this bench is 511.240 feet. This is a fraction of a foot higher than the value used by the U. S. Lake Survey, and the U. S. Geological Survey, and 1.428 feet higher than the elevation originally used by the Erie Canal.

The precise figures given below are from the data of the City Department of Engineering. The benches are located between the sidewalk and curb, and the iron cover-plate is marked R.T.S. This plate should not be confused with similar benches of the Rochester City Survey, which lie in the sidewalks, and are designated R.C.S. The other figures are mostly by aneroid and are subject to a small correction.

B. M., Winton Road and Hillside Ave., northwest corner,	511.581
Summit of Winton Road, pavement	515.
Crest of ridge west of Winton Road (south edge of Elam gravel pit)	560.
Northeast corner of Reservoir Park	600.
Top of knoll east of the steel reservoir (Lake Ontario Water Company)	625.
Bottom of kettle close east of steel reservoir	585.
Base of the steel reservoir	620.
Top of high knoll west of the steel reservoir	640.
Bottom of kettle northeast of Cobbs Hill reservoir	525.
Cobbs Hill Reservoir, water surface	636.
Cobbs Hill Reservoir, coping of wall (under fence)	641.
Cobbs Hill Reservoir, cement walk, close to coping	640.5
B. M., Monroe and Highland Avenues, northeast corner ..	544.753
Summit of Monroe Avenue, near gate-house	546.
Top of Klinck Knoll, above Hillside Home	685.

The Pinnacle; ground at the geodetic station	748.7
West of the Pinnacle; terrace in cemetery (Brennan and Hughes plots)	700.
Terrace in cemetery, east of Clinton Street, by Cochrane monument	648.
B. M., Clinton, S. and Field Streets, northwest corner	565.889
Summit of Clinton Street S.	586.
Crest of ridge west of Clinton Street	648.
B. M., Goodman Street and Highland Ave., northwest corner	545.285
Summit of Goodman Street S.	581.
Top of ridge, Goodman Street cut	623.
Highland Park; ground at Memorial Pavilion	652.
Highland Reservoir, water surface	636.
Highland Reservoir, coping of wall	640.
B. M., South Ave. and Alpine Street, northeast corner ...	598.180
South and Reservoir Avenues, pavement	610.
B. M., South and Highland Avenues, southwest corner ...	595.141
B. M., Mt. Hope Avenue and Bonivard Street, southeast corner	565.842
B. M., Mt. Hope and Reservoir Avenues, southeast corner	614,232
Mt. Hope Cemetery; summit of Indian Trail drive, by Henry A. Ward monument	644.
Mt. Hope Cemetery; surface of "Sylvan Water"	610.
Mt. Hope Cemetery; top of highest knoll, by Mt. Hope Avenue	676.
Mt. Hope Cemetery; plauteau-ridge at Firemen's Monument	585.
Oak Hill; highest point in golf ground	575.
Oak Hill; highest point, by R. R. cut	584.
Ground at Medical College	540–545
B. M., Elmwood Avenue and Park Road, southwest corner	527.365
Genesee River, Barge Canal Harbor	513.
B. M., Elmwood and Plymouth Avenues, Av. Ext. northwest corner	522.772
B. M., Brooks Avenue and Thurston Road, southwest corner	568.009

Comparison with Neighboring Moraines

The distinguishing feature of the Pinnacle Hills moraine is its extended or linear form, with narrow breadth. From Brighton westward to the Genesee River, and west of the river for six miles, it marks a fairly definite stand of the ice-front. All the other conspicuous moraine deposits in the region are irregular and scattering, indicating variable and receding positions of the ice margin. Figure 5 shows the near by and most striking example.

The westward extension of the Rochester moraine is depicted in figures 2 and 3; and the stretch past Spencerport and Brockport, to the western limit of Monroe County, is shown in figure 4. Here the moraine is very unlike the Pinnacle range, being scattered in more or less detached masses over a belt three miles wide.

North of the Pinnacle moraine, and therefore later in time, a few morainic masses have survived the leveling action of lake waters, but they will not resist human destruction, and should be put on record.

In the west edge of the city a group of sand knolls occupied the space between West and Chili Avenues, west of Lincoln Park. Four lines of railroad tracks, the barge Canal and Buell Avenue, have dissected the knolls. At the present time (1923) a large and deep sand pit is open on the west side of Buell Avenue, between the two railroad freight lines. The area appears in figure 2. About one-half mile north of the Lincoln Park kame area is a prominent moraine ridge, which carries two contours on the topographic map. It is indicated in figures 2 and 3. The Charlotte branch of the Buffalo, Rochester & Pittsburgh Railroad cuts the east end of the ridge, and the Barge Canal passes the west end.

East of South Greece a group of knolls lies in the embayment in the Niagara limestone scarp, and faintly indicated in figure 2. The shore line of Lake Dawson passes through this tract and wave-work has had some smoothing effect.

The level and smooth surfaces west of the city, with silted stretches and swampy areas, were produced by the waters of sub-Dana and Dawson Lakes.

In the eastern part of the city a conspicuous mound lies north of Blossom Road and east of the Central Railroad. The streets Hampden, Middlesex and Marion have been graded through this kame. Another small area of low sand knolls lies on Blossom Road, east of Winton.

Probably other mounds of gravel or sand could have been recognized in former years, but are obliterated in the growth of the city

Passing south of the Pinnacle range, we find an area of sand north and south of Mortimer Station on the West Shore Railroad, and traversed by the Erie and Lehigh Valley railroads. The sand knolls are low, detached and inconspicuous, having been softened in relief by the waves of the Scottsville waters. They are spread over an area a mile wide and two miles long, northeast by southwest.

South of the Spencerport-Brockport moraine only occasional and detached masses of drift are found in the town of Ogden. In Riga, moraine drift is seen along the N. Y. Central main line from Chili Junction to Churchville.

In the town of Chili, and south of Coldwater Station is a conspicuous and singular group of kames, indicated in figures 2 and 3. They lie in a belt about a mile wide and two miles long, northeast by southwest. They stand 20 to 40 feet high above the plain. They have no orderly arrangement, but individually they have an east-and-west elongation. Two drumlins lie along the east side of the kame belt. Upon the highest summits, 600 to 620 feet, are numerous granitoid bowlders. They appear to represent gentle outwash into quiet waters of Lake Dana. Like the other moraine areas they have no correlating land valley to direct the glacial drainage, and no feeding esker. The outwash was probably englacial or superglacial.

Before the front of the Quebec ice-sheet had receded to the arcuate line of the Rochester-Albion moraine it had built massive moraines, some of which exceed the Pinnacle Hills in height and in volume. These were briefly described in paper No. 3 (and in the Journal of Geology, Vol. 4, 1896, pages 129–159), and they deserve more detailed description than can here be given; and especially should be correlated with lines of the ice-front recession.

The Mendon Hills kame area, in Mendon and Pittsford towns, is shown in figure 5. This is the most massive and isolated moraine group wholly within Monroe County, and forms some of the highest ground, rising to 840 feet. The hills have an irregualr grouping, with an area of four square miles. They lie in two series of gravel kames, and kettles, with high relief and striking topography. An intervening valley holds four lakes, the only lakes of note in the county. Each series of kames has a massive ridge or esker, mapped by Giles in paper No. 12.

The remarkable Mendon kames are surrounded by drumlins, which are strong on the northeast, in the direction of the ice movement. The isolation of the area is striking, with no relation to any valley or apparent line of glacial drainage. The deposit probably correlates in time with the belt of drift westward toward Scottsville, and eastward with the Irondequoit Valley kames, and the high Baker-Turk Hills mass.

Between Allen Creek corners and Pittsford, and lying between the N. Y. Central main line and the Auburn branch, in an area of some four square miles of drift with singular topography. This was deposited in Lake Dawson. It has the aspect of an eroded or much broken plain, with main level at 440 feet. Some areas are 460 and 480 feet.

The valley of Irondequoit was naturally the catchment basin for the heavy drift from the glacial outwash. An area south of Bushnells Basin has a remarkable display of kettles, among the gravel knolls. Bullhead Pond occupies a deep kettle.

The elevated tract between Fairport and Victor, commonly known as Turk and Baker Hills, is the largest drift deposit and the highest in the county, rising to 935 feet. The highway over Baker Hill, 928 feet, is the highest road in the county. The mass is complex in origin. The north flank, toward Fairport, is distinctly drumlin. The south part has morainal surface, but this may cover drumlins, or possibly conceal a core of rock. The southwest flank carries excellent delta plains, built in Lake Dana, at 700–715 feet. The Baker Hill was swept by Lake Warren waters, at 920 feet.

The more southerly of the two southeast corners of Monroe County touches the west slope of the largest kame-moraine area, known as the Victor area. Lying mostly in Ontario County, it is mapped on the Honeoye and Canandaigua sheets. The kames rise to 1.100 feet, and the County corners on the ridge north of Ionia Station known as the Hopper Hills, at 1.020 feet, the highest point in the County.

Acknowledgment

The writer of this paper makes grateful acknowledgment to Professor George H. Chadwick, Dr. A. C. Hawkins and Milroy N. Stewart for suggestions and criticism; to Dr. Hawkins and Mr. George R. Rohr for transportation and help in the field; and to the officials of the City Engineer's Office for courteous assistance in securing data.

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MENDON KAMES
View in the eastern range, looking northwest

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
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THE MENDON KAME AREA

By Herman L. Fairchild

CONTENTS

Foreword

The numerous and striking glacial features of western New York have been the subject of many scientific papers, and the remarkable group of gravel hills in the town of Mendon, 10 miles south of Rochester, has not been overlooked. But the hills are deserving of special description, because they have no superior in their display of the peculiar characters of morainal deposits. The pictorial record is made in anticipation of the possible defacement by the growth of population and the march of improvement(!) The destruction of some of the most beautiful portions of the Pinnacle Range is a warning of the danger to other features of our finest scenery.

In the varied and beautiful topography of western New York there is nothing more unusual and attractive than the Mendon kames, with their included phenomena. The area is not appreciated because the features are not really seen from the highways. Few people today see anything that is invisible from their automobile. The three roads which lie alongside the ranges of hills afford merely a suggestion of their singular characters. But a little climb up

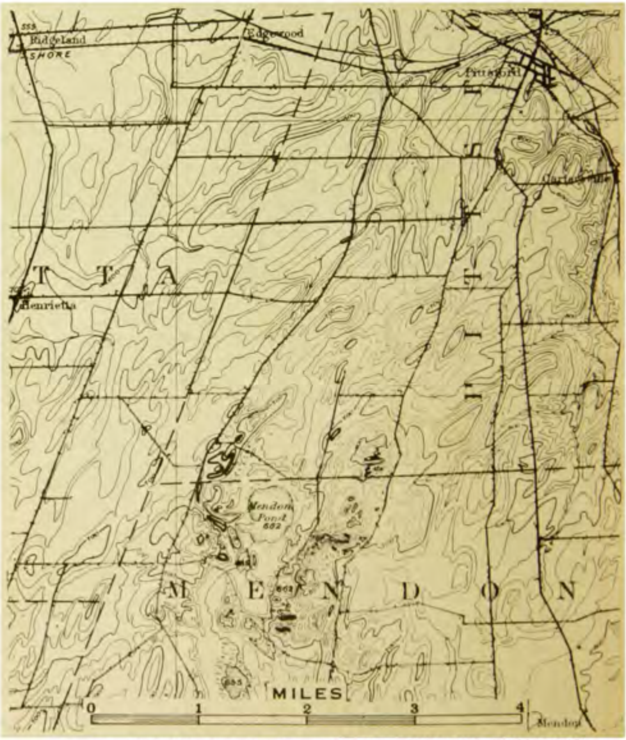

Figure 1. **MENDON KAME AREA AND SURROUNDING TERRITORY**
From the Rochester topographic sheet

almost any of the higher roadside knolls will give a view of hills and hollows with surprising form and relief.

The four most singular and romantic geologic products of the continental ice sheet are found here in excellent display. These are the drumlins, which surround the kame area (figure 1), and the kames and eskers which constitute the groups of hills, with their included basins, or kettles. A century ago these objects were insoluble puzzles. And even with the rise of the new science of

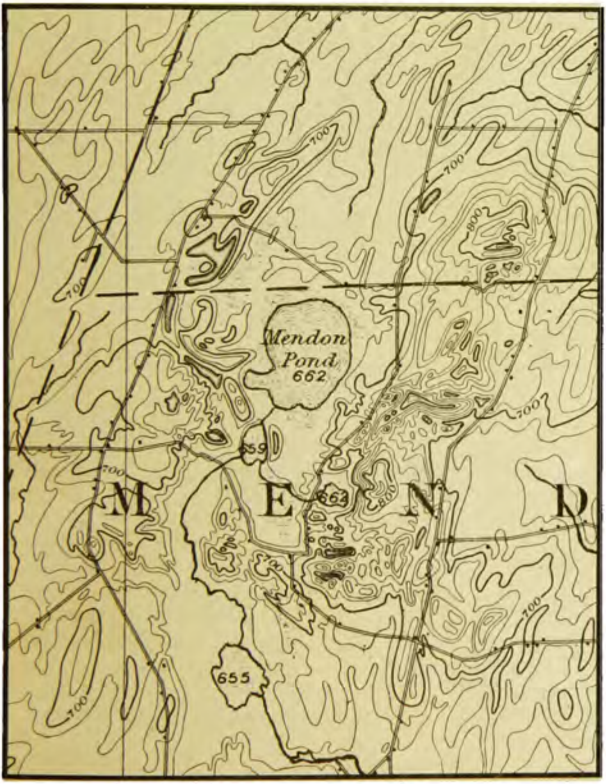

Figure 2. **MENDON KAME AREA**
Enlarged from the Rochester sheet. One and one-half inches equal one mile

glaciology these phenomena were not readily understood, because they are not produced by mountain or stream glaciers, which were the early subject of glacial study. These features are the work only of extensive ice sheets or continental glaciers, and probably under temperature conditions not found in the ice caps of Greenland and Antarctica.

Concerning the origin of drumlins, kames and kettles[1] there is no longer any doubt. And the only question relating to eskers is whether they were sometimes built in open trenches, ice-walled canyons of the glacier, or were always laid in tunnels beneath the ice sheet, subglacially.

The few published references to or brief descriptions of the Mendon moraine are in the papers listed at the close of this writing.

The Mendon kame area, with its unusual display of glacial topography and phenomena; its group of lakes, so rare in this region; its peculiar botanical interest; its elevation above the surrounding country; its definite and limited area; its Indian trails and camp sites and its high educational value in the study of nature, should be preserved inviolate as either a State or a County park.

Location; Area

This group of mounds and basins, knobs and kettles, piled about two large eskers, lies in the towns of Pittsford and Mendon some ten miles south of the City of Rochester. The area is bounded on the west by the Clover Road and on the east by the Pittsford Road. It covers about two miles east and west by two and one-half miles north and south. The features with high relief, sharp knolls and deep kettles, form two north and south belts with a low and smoother intervening tract. This middle tract holds four lakes, and is traversed along the east side by the Douglas Road. Two roads cross the area, the Canfield Road north of the large (Mendon) lake, and the Pond Road in the southern part of the area. These geographic features are shown in the maps, figures 1 and 2.

These Mendon lakes, locally called "ponds," are the only natural bodies of standing water in Monroe County, excepting three lakelets near Bushnell Basin, in the Irondequoit Valley, and Blue Pond, three miles west of Scottsville.

A fair imitation of the Mendon kames and kettles is seen in the higher ground of Mount Hope Cemetery, with suggestions in other parts of the Pinnacle range of morainic hills (see paper 9 of the

[1] For a glossary of technical terms in glacial science see pages 144–148 of this volume. (Paper number 9 of the appended list of writings.)

appended list of writings). In the axis of the upper Irondequoit Valley is another example of this striking topography. The kame-moraine area having more general resemblance is that of the Junius Ponds, in the town of Junius, midway between Lyons and Geneva. A feeble imitation lies east and northeast of Batavia, traversed by the New York Central Railroad.

As the kames are hills of gravel built by streams pouring out of the melting ice sheet, it would be expected that the drainage would be guided by the valleys or depressions beneath the thinning ice. Such is the case with the Irondequoit area. But the Mendon area, like the Pinnacle moraine, stands high on a plain, with no suggestion of subglacial or topographic control of the drainage. With the bold relief and the deep and steep-walled basins the Mendon kames, and their included eskers, are the choicest example of the peculiar product of glacial ice and water acting in concert.

Origin; Lake History

The kames are a product of the constructional (depositional) work of the marginal ice during the melting phase of the ice sheet. They were built by streams flowing from the ice front, and emerging from beneath the ice (subglacial), and perhaps under hydraulic pressure.

During its long journey from the north the glacier had gathered great quantity of rock-rubbish from the land over which it rubbed. Most of this load of drift was held in the basal portion of the ice sheet. During the waning and disappearance of the ice cap, by marginal melting and recession (northward) of the ice front, the burden of drift was dropped on the land. (See figure 1, page 150 of this volume, paper No. 9.)

Under unusual combination of mechanical conditions the basal, or subglacial, load of drift was piled as drumlins by the overriding action of the ice sheet. In the Rochester-Syracuse region we have the finest display of drumlins in the world. The Mendon kames lie in the southern margin of the heavier drumlin area.

Another large part of the drift load fell within the grasp of water, flowing beneath the ice sheet, and some part of this, the coarser material, was deposited in the beds of the subglacial streams, as eskers. (Plates 80, 81.)

The remainder of the glacier's drift load, which had escaped deposition beneath the ice as drumlin and esker, was bound to be dropped at the melting ice margin. All the marginal drift falls in the class termed moraine, whether left directly by the mechanical work of the ice itself, as till, or indirectly by the draining water. Hence the knolls or mounds of gravel and sand built at the mouths (debouchures) of the streams are, in the general classification, morainal, but are given the special name of kame. The following table shows the nature and genetic relationship of four forms of glacial deposits.

Forms of Glacial Drift

Place of Deposition	Manner of Deposition Ice-Laid	 Water-Laid
Beneath the ice sheet; and extended in direction of the ice movement,	Drumlin	Esker
At the margin of the ice sheet, and transverse to the ice movement; Frontal Moraine,	Till-moraine	Kame

The Mendon kames were not only built at the edge of the ice sheet but were piled in the deep water of a glacial lake which faced and laved the ice front. It appears probable that all kame areas and typical kames were built in standing water. The comparison may be the conical heaping of sand when poured through a funnel. On the open land, with free run-off of the glacial drainage, it is supposed that the detritus in the grasp of the streams would be spread out as plains, instead of being piled as cones or mounds, or else would be distributed down the stream valley as "valley train" drift. Essentially, the kames are incipient deltas, and if the ice front would remain stationery for sufficient time, and the water not too deep, the detritus would build a plain, a true delta. With lowering waters the plain might have a series of terraces. But in western New York the glacier was melting too rapidly, and the depth of the facing water was too deep, for the production of plains. The inconspicuous plains or level tracts which may be seen on the Mendon kames were produced by the leveling action of waves after the kames were built, and while the waters were falling away.

The building of the Mendon kames is closely involved in the glacial lake history of western New York. The remarkable series of ice-dammed waters which occupied the Genesee Valley and the Ontario lowland have been the subject of numerous published articles, some titles of which are listed in the bibliographies in the papers 8, 10 and 11 of the appended list of writings.

For present purpose it is sufficient to say that the kames were built in one of the later lakes of the glacial succession; in the waters of the great Lake Warren. This water body covered much of the basins of Erie and Huron, and had outlet westward across the state of Michigan into the glacial Lake Chicago. The lake extended as a narrow belt of water in central and western New York between the south front of the ice sheet and the highland on the south, and reached eastward to the meridian of Otisco Lake. Over the Mendon area its surface elevation was about 900 feet above ocean (present upraised elevation), and it overtopped the highest Mendon hill, which is contoured as 840 feet. The kames were built in submergence. As indicated above, if the great mass of drift in the kames had been piled at the surface of the lake it would have formed a wide and splendid delta plain, instead of being heaped into the "eggs-in-a-basket" form which we find today. (Plates 78, 79.)

When the ice front in the Syracuse district weakened so as to open escape for the Warren waters eastward, toward the Mohawk-Hudson, the lake fell away into the long-lived Lake Dana, which had its outlet at Marcellus village. The erosional work of the waves of Lake Dana is found through western New York at about 700 feet elevation. The higher kames at Mendon stood as islands in the Dana waters. From favorable points of view some inconspicuous leveled or smoothed tracts may be seen on the east and the west side of the kame area, where the waves had greater force. Perhaps the best view point is on the Canfield Road about one-fourth mile east of its junction with the Clover Road. This is the high point in the road, and by the topographic map is precisely 700 feet. Looking north the perfectly smooth and horizontal lines, due to the leveling work of waves, are clearly seen; along with the wave-cut cliff curving around a knoll, some 40 feet in height. Looking southward the leveling is evident, as all the summits lie in the same plane. The Dana leveling is also seen, looking eastward, from the knoll west of the Big and Deep ponds. This knoll is the southern end of the path regarded as an Indian trail (see below).

Wave-work of Lake Warren appears as erosional plains on the southern flanks of the Baker Hill, north of Victor, at 920 feet elevation (see plate 2 of this volume of Proceedings, in paper No. 8).

The shore cliffs and gravel spits by Lake Dana appear on many drumlins west and northwest that rise to or above 700 feet.

Apparently the waters of Lake Dana fell away so promptly that they left no evident erosion features below the summit plane of 700 feet, of strength sufficient to survive the atmospheric agencies of many thousands of years.

Relations

An examination of the Rochester sheet of the topographic map will give an idea of the geographic features of the country surrounding the kame area. A portion is reproduced here as figures 1 and 2. It is noted that the kames lie in a drumlin area of high altitude, and a little west of south of the Irondequoit depression. Northward, toward Pittsford the drumlins are strong. Westward the surface is also drumlinal but not so strongly ridged. The twenty-feet contours of the map do not fully indicate the drumlinal character of the surface. Southwestward the drumlins reach to the Corniferous escarpment, but the glacial overwash partially buries the minor inequalities. Drumlins lie immediately south of the kame area at the village of Mendon Center. Eastward and southeastward the country is less hilly for several miles, to the Victor kame area.

The drainage from the lakes and the enclosed valley is immediately southward, forming the source of Irondequoit Creek. After passing Mendon Center the creek swings eastward to Fishers, and then northward to Irondequoit Bay. From the borders of the kame area the drainage is radial in all directions.

In very sharp contrast with the Mendon kame-moraine is the range of the Pinnacle Hills, in the City of Rochester: (9, figure 2, page 151.) The latter is of later origin than the Mendon deposit, and with radically different form, being extended east and west, in linear form, and definitely a part of the frontal moraine extending west to and beyond Albion. But the Mendon kame-moraine is not a portion of an extended, definite belt of frontal moraine. On the contrary it is notable as a detached and isolated area, rising out of a plain, and surrounded by drumlins. It is evident that the mass is frontal moraine deposit, but the character and behavior of the ice front during the phase of the kame construction was very unlike that when the Pinnacle range was built.

KAME-MORAINE TOPOGRAPHY
Views in the east range

However, the Mendon area may be correlated with other morainal deposits on the east and west. In a belt westward heavy drift is found on and among the drumlins north of Rush village and either side of the Rush Reservoir. Eastward, the heavy drift on the southern flank of the Baker Hill, north of Victor, is doubtless contemporary. Farther east the glacial rivers have removed the morainal drift, or prevented its accumulation. Far east, and north of Lyons, the Junius kame area exhibits characters similar to the Mendon area, and may correspond in time of deposition.

Topography

The best available map of the kame area is the Rochester topographic sheet, with its imperfect contouring in 20-feet interval. This is reproduced in black and white in figures 1 and 2. The two remarkable eskers which constitute the core or heart of each series of kames are strikingly shown in plates 80 and 81, reproduced from Giles' paper (12). The figures for altitudes are from the Rochester sheet.

The Mendon kames are the third highest ground in Monroe County. The highest point of the County is the extreme southeast corner, on the west border of the Hopper Hills, one mile northeast of Ionia. The altitude, as shown on the Canandaigua sheet, is 1,020 feet. The second highest ground is the Baker Hill which rises to over 930 feet. The U. S. Lake Survey station, by the Baker residence, is 928 feet; shown on the Macedon sheet. Two of the Mendon kames in the east range rise to 840 feet. This altitude of the kame group is a notable character. The surrounding plain is only 660 to 680 feet, and even the surrounding drumlins are only 700 to 720 feet, except one close east, at 740 feet. It is seen that the crests of the highest kames are 120 feet over the drumlins, and 170 feet above the surrounding surface. In this element of excessive height the Mendon kames resemble the Baker-Turk Hill mass, six miles east; which was doubtless contemporary in time of construction and similar in partial origin.

The form of the kames is shown in plates 78, 79. Of pronounced knob and basin type, it is in strong contrast with the near-by drumlins, which are smooth, oval hills or ridges. The kames are mammillary or conical, enclosing numerous deep basins or kettles. Their billowy aspect has suggested comparison with "eggs in a basket."

The altitude figures for the lakes on the topographic map are questioned. The Mendon Pond is marked 662 feet, and Deep Pond, a short distance south, and connected by a channel with no current, is marked three feet lower.

Unfortunately it is not easy to determine precise elevations in the area. The Rochester sheet is one of the earlier maps of the Geological Survey. No "benches" are given on the map nor any altitudes for road intersections and salient points, as in recent and more perfect mapping. To check the elevations in the district it may be necessary to run lines of accurate level from the Barge Canal benches at Pittsford.

Composition; Structure

Kames and eskers are water-laid material, sand and gravel. The fragments of rock had been held in the grip of the ice sheet, and some of them were scored and planed by rough treatment. Finally, with the waning of the glacier, the streams from the melting ice gained possession of the stones and gave them "water treatment." Rolled and tumbled and shoved for long distances the stones were worn into smoothed and rounded forms, as bowlders, cobble, gravel and sand (figure 3).

A minor part of the esker ridges is till, or unassorted rock-rubbish contributed directly by the ice without water interference. Sometimes the walls of the stream channels, or the roofs of the subglacial tunnels, fell in and carried ice-drift into the stream deposits. And sometimes a little advance of the ice pushed its drift into the gravels, and even mashed and crumpled the layers, destroying the bedding and structure of the water deposits. We can readily imagine how, in various ways, the glacial stuff was left on, or in, the stream-borne deposits.

The hills are partly pasture land, with many cultivated fields. Excavations or exposures are few, but sufficient to show composition (figure 3). The most abundant rock is Medina sandstone, which is estimated at one-half the total mass in observed sections, and also of the piles and fences of cobble and bowlders in the middle valley, where cultivation is prevalent. The explanation is that Medina sandstone is the only very hard near-by terrane on the north. Many bowlders of crystalline rocks occur, which have been brought from the Adirondacks or from Canada. Some blocks of

Lockport (Niagara) limestone are found; two large blocks lying on a summit at 720 feet.

The varied and interesting structures and composition characteristic of kames is excellently displayed in the gravel pit on the farm of J. R. Hopkins, on the east side of the Clover Road.

The tops and slopes of the hills are frequently of material so fine and adhesive as to be clayey. Evidently this was deposited from the lake waters which covered the hills during, and subsequent to, their construction.

Figure 3. **KAME GRAVEL**
Excavation east side of the Douglas Road

The rock floor of the district is deeply buried under the glacial deposits. The underlying rocks are the Salina shales, and they were deeply eroded before the ice sheet overspread the country. On the Howard farm, on the extreme western edge of the area, it was said that a well starting on the 700 foot contour was driven 130–140 feet without reaching bed-rock. On one of the knolls in the southern part of the east range a well at the 680 contour was said to penetrate 130 feet of clean sand without rock. South of the kames, on the sandplain, farm of Judson F. Sheldon, rock was reported at depth of 69 feet, the altitude of the plain being about 600 feet.

Features

Drumlins. These were built beneath the ice sheet by the piling-on and rubbing-down action of the ice during a phase when it was no longer able to carry all of its load of drift. (The New York drumlins have been described and the mechanics of their building discussed in Bulletin No. 111 of the N. Y. State Museum.) The depth of the ice sheet in which the Mendon drumlins were erected is unknown, but is estimated at perhaps 500 feet. At that time the edge of the ice sheet was miles southward. A diminutive drumlin stands in the valley near Deep Pond.

Figure 4. **EAST RANGE ESKER**
View looking southwest. Cattle-paths on the east slope

The Mendon kames were piled at the ice margin, long subsequent to the building of the neighboring drumlins. It is possible that some drumlins are buried in the kame hills. The massive glacial deposit of the Turk-Baker hills quite certainly has a drumlin base.

Eskers. The two north and south ranges of kame hills contain two eskers of unusual size and form. They have been described by A. W. Giles in a masterly paper which is part of volume 5 of the Academy Proceedings (12, pages 217–223). Plates 80, 81 are reproductions of his maps.

Eskers are ridges of gravel, often very coarse and poorly assorted, which were accumulated in the beds of overloaded streams. The weight of observation, as well as of theory, favor their subglacial origin, especially of the typical forms, with great length in

Survey and map by A. W. Giles

ESKER EAST OF MENDON POND IN THE MENDON KAME AREA comparison with the cross-section. The streams which drain alpine glaciers, and the Malaspina ice sheet in Alaska, emerge from subglacial tunnels. Water from the melting of the ice surface (ablation) finds its way downward by fissures (crevasse) or by melting its own passage.

The eskers in the two ranges of kames are so irregular in form and so confused with or surrounded by the kames that they are not readily recognized. The one in the east range has greater length, but the other has higher relief and steeper slopes.

There is intimate genetic relation between kame and esker, and both may be product of the same stream. The kame knolls are outwash of detritus piled at the emergence of the glacial stream, at the fluctuating and ragged edge of the ice. The esker is the coarse material dropped by the stream in its bed when the volume and velocity of the flowing water is incompetent to carry all the load. The stream in its course lays the esker and at its terminus piles the kame.

The "feeding esker" may sometimes be found upstream from a kame. During the rescession of the ice front kames are often built on or against the esker, producing an irregular and knobby ridge. The eskers in the Mendon kames have been thus confused or obscured by the subsequent kame construction.

Like drumlins, eskers indicate the general direction of the local ice movement, for the reason that a stream under the ice sheet could not persist with a direction of flow transverse to the ice movement. They could live only in accord with the ice flow, which in western New York was south to southwest.

Eskers should be sought in south-leading valleys, where the subglacial drainage would tend to concentrate. A series of interrupted ridges and knolls lie along the Lehigh Valley railroad, on the west side, between Cedar Swamp station and Rochester Junction, which can be seen from the car window, especially when the trees are bare. These are mapped and described in Giles' paper.

A mile south of the Mendon kames is a conspicuous chain of knolls that is regarded as an imperfect esker, or eskerine. This surmounts a drumlin, close east of the road to Honeoye Falls. The four connected knolls are locally known as the "Dumpling Hills." The altitude, 740 feet, and height above the plain, with a lone tree on the bold north end, makes the little esker very prominent.

Kettles. The basins or bowls, termed kettles in glacial parlance, are singular features. They are not normal products of stream work, and before the rise of glacial geology they, like drumlins and eskers, were mysterious phenomena.

Among the Mendon kames are numerous, large and splendid examples. (Figure 5.) They are not visible from the highways, but may readily be seen by climbing the knolls close to the roads, especially on the east of the Douglas road. They are difficult subjects to photograph with a small camera.

The walls of the basins commonly rise as steeply as the material,

Figure 5. KETTLE IN THE EAST RANGE
Looking north

gravel or sand, will rest, or at the "angle of repose." In some cases the height is 100 feet.

Kettles are not erosional; that is, they were not made by removal of materials, or by excavation. They are constructional, in a peculiar way. Some of the more irregular, larger and shallow basins, like those holding the larger lakes, may be due to deficiency of filling at the time of the moraine deposition. But the deeper, symmetrical or subcircular kettles were originally occupied by blocks of ice, detached by the unequal melting of the ragged ice margin. Probably most of the ice blocks were entirely buried in the detrital outwash, and never melted until the lake waters were drained away and the area exposed to the air .and the leaching rains. Then the drift cover and walls slumped in, leaving the steep-walled bowls.

Perhaps some larger ice blocks were only surrounded by the ice and stream drift, and were not entirely buried. Such basins stand intermediate in their origin between the typical kettles and the broad basins of unfilled spaces.

The persistence of buried ice until the standing waters were removed was due to the greater density and weight of the colder water. The temperature of the drift about the ice must have been quite 32° F. As any portion of the surrounding water became warmer, up to 39° F. its density increased and it remained in the depths, thus insulating the ice and inhibiting the rapid melting. It

Figure 6. MENDON POND
Looking west from the east range esker

may be noted that the bottom waters of very deep lakes, like Ontario and Seneca, are permanently at 39 degrees.

Lakes. In geologic terminology the names pond and pool are used only for artificial bodies of water, while natural water bodies are called lakes, lakelets and tarns.

The location, size and outflow of only four of the lakes in the kame area are shown in the maps, figures 1 and 2. But other lakelets exist, hidden in the deep kettles. One west of the Mendon Pond, in a great well-like kettle, is called Black Pond. Several lakelets lie north of the Harris Pond, at least in wet seasons, and are indicated in Giles esker map, plate 80.

The "Big Pond," the most northerly, and the head of drainage, has an area of about 100 acres, and a depth of about eight feet.

The Harris Pond lies nearly surrounded by the kames on the east side of the valley. It is only a few acres in extent, but is said to have a depth of 24 feet. Deep Pond is mostly shallow but is said to be 34 feet deep in one place. Mud Pond is shallow, as its name implies. The margins of the lakes are mostly swampy.

There are all gradations in size and position of the kettles, from the lowest, with or without lakes or swamps, and those of great depth, to the shallower depressions high in the hills which can never hold any water. Naturally the only basins which can hold lakes are those with impervious bottoms, probably compact, sub-glacial drift. Below the lake surfaces the surrounding sands and

Figure 7. MENDON POND
Looking northeast from Knoll at south end of the Indian Trail

gravels must be always saturated with water. Hence the lake levels are not very sensitive to the changing seasons.

Botanical Interest

During many years the Section of Botany of this Society has explored the Mendon district in the intensive study of the flora of Monroe County and surrounding territory. An early collector and student of the Mendon plant life was George T. Fish. Subsequently Milton S. Baxter, Warren A. Mathews, Douglas M. White and Ellsworth P. Killip took up the work, continuing to the present time.

The special botanical feature of the Mendon district is the swamp flora, found in the bogs of the kettle basins and in the swamps surrounding the several ponds. The flora here is comparable to that of the Bergen swamp, in Genesee County. In the latter area the predominant flora is that which is characteristic of marl bogs, or calcareous waters; while in the Mendon area the sphagnum bog plants predominate.

The Mendon flora is especially rich in orchids and insectivorous plants. The heath family abounds. Several rare species of carex occur, among them *Eleocharis interstincta*, (Vahl) R. & S., not reported elsewhere in New York state. The following two species are found in our botanical district only in Mendon: the Dwarf Mistletoe *Arceuthobium pusillum*, Peck, parasitic upon the Black

Figure 8. **DEEP POND**
Looking southeast from Knoll at south end of the Indian Trail

Spruce, *Picea mariana*, (Mill) BSP., and *Utricularia resupinata*, B. D. Greene.

The plants of the Mendon district are listed in the published Plant List of Monroe County, in these Proceedings, volume 3 (1896), pages 1–150; with particular notice on pages 8, 9. Additional species are recorded in the Supplementary Plant Lists, volume 5, pages 1–38, 59–121.

Aboriginal Occupation

The Mendon Pond Trail

By Arthur C. Parker

When Lewis H. Morgan was preparing the manuscript of his now justly famous "League of the Iroquois" he paid special attention to the subject of Indian trails. Indeed his "Skenandoah Letters" in the *American Review* contain much of interest about trails, gleaned from this intimate association with the New York Indians.

Many of the most important roads in our State and many more by-paths are built directly upon older Indian routes. This fact is so well known that it has become a tradition. In fact, among a considerable class of our population great pleasure is found in following the routes that the red men once took, and in revisioning ancient conditions. To find an Indian trail, however, that has survived the age of improvements is another thing. A few thoughtful spirits have attempted to hunt out and tread upon the identical pathways that the Indians left behind.

Oddly enough one of the most famous may still be seen in the rocks of the northern end of Manhattan Island,—in the very metropolis. One important survival may be seen near Belvidere in Allegany County, and there is little doubt but that some of the paths around Irondequoit Bay are survivals.

There is yet another trail which both history and tradition unite in proclaiming an Indian path. It was reported to the writer by Professor Fairchild, and it was in his company with Mr. George Selden, a local historian and Mr. Henry Selden, Vice President of the State Archeological Association, that the visit and inspection was made. The path is on the ridge of the long esker running north and south through the J. H. Hopkins farm, on the east side of the Clover Road, just west of the Mendon Pond. The esker rises like a knife edge leaving only a narrow surface for a path. This path is plain enough, and worn about two inches into the soil, though in places it may be deeper. It runs over the ridge to a point overlooking both the Mendon and Deep ponds and then descends the hill and skirts the swamp, coming out on the Clover Road. A by-trail, even more deeply worn in places, diverges to the east and runs to the cove of the big pond. Here are ample evidences of old camp fires. Fishermen at the present time in searching for bait frequently dig down in the earth and find the embers and refuse of ancient fires.

It has been sufficiently established that the Clover Road follows the old Irondequoit-Ganarqua trail. It was this trail that Denonville followed when he invaded the Seneca country in 1687, and indeed his journal mentions the "three ponds."

The question before us, therefore, is whether or not the trail over the esker was a portion of the main trail or not? The fact that there was a more level area to the west, and one which would avoid the swamp, seems to indicate that the esker trail was not a part of the main trail, but a by-path to the ponds where fish were abundant. It would seem an odd circumstance to find a trunk roadway diverging for the purpose of traversing a narrow ridge; and this was probably not the case.

My conclusion, therefore, is that since we have evidence that the Indians did use the ponds, and that the main trail passed near by, the ridge trail is a survival of the old Indian trail from the Irondequoit trail to the ponds.

That it is a survival seems to be attested by tradition. That it is not a path made by domestic animals appears from the fact that our evidence shows that horses and cattle were never pastured in this particular area. The swamps were too dangerous. That it was not made by hunters and fishermen is indicated by the fact that present day traffic is not sufficient to have worn the path so deeply. The modern hiker who traverses it leaves but an imperceptible impression, as we discovered by experiment in passing and repassing many times.

That it is the survival of an Indian trail, therefore, seems certain. To have reached the pond the Indians would have been compelled by the very terrain to walk the narrow ridge in the precise lines now traversed by the path. We are fully warranted in concluding that the Mendon Pond trail is the best, if not the only, example of a surviving Indian trail in the vicinity of Rochester.

Aboriginal Sites on the Mendon Ponds

Many of the slopes about the Mendon Ponds have traces of aboriginal occupation upon them in the way of fire-broken stones, net sinkers, arrow points and now and then a celt. One considerable site is to be found on the east side of Big Pond and at about its middle point. In general the culture seems to be Algonkian, though there are traces of the Iroquoian. The Algonkian peoples came long before the Iroquoian, and probably fished in the ponds for many centuries until driven out by the Iroquois at some period between 1200 and 1300 of our era.

The later Iroquois explain the gravel hills, such as are seen on both sides of the ponds, as the spew of monster lizards that plowed into the earth and endeavored to devour it. In anger the Thunder god shot them with the gleaming arrows that flew from his eyes when he caught the culprits, whereupon the monsters disgorged the sand and gravel and then died. The shapes of their bodies may still be seen.

Historical Evidence of Occupation

Mr. J. H. Hopkins, who owns part of the land upon which the esker trail is situated, stated to the writer that his grandfather cleared the farm and found the Indian trail over the ridge leading to the ponds. He stated that originally it was much longer and ran over the ridges to the north. The older settlers, he said, never doubted that the trail had been made by the departed red men.

Just north of his present house, in plowing, he found the ruins of an old cabin and some shards of blue china. Whether this was an Indian hut or one occupied by a settler he cannot tell, but since the Seneca Indians lived in the Genesee valley as late as 1838, and had free access to their old haunts, the chances are about equal as to the nationality of the cabin's occupants. At that time the Indians had European dishes and lived in log cabins. The fact that the Indians left at a relatively late time,—less than a century ago,—strengthens the arguments in favor of the Indian origin of the trail.

List of Writings

The published papers listed below contain references in the present article and some mention or brief description of the Mendon kames and related features. A fuller list of papers on the glacial geology of western New York is given in papers 8, 10 and 11.

1. C. R. Dryer. The glacial geology of the Irondequoit region. *American Geologist,* Vol. 5, 1890, pp. 202–207.
2. H. L. Fairchild. The kame-moraine at Rochester, N. Y. *Amer. Geol.* Vol. 16, 1895, pp. 39–51.
3. ————Kame areas in western New York south of Irondequoit and Sodus bays. *Jour. of Geol.* Vol. 4, 1896, pp. 144–150.
4. ————Kettles in glacial lake deltas. *Jour. of Geology,* Vol. 6, 1898, pp. 589–596.
5. ————Glacial lakes Newberry, Warren and Dana, in central New York. *Amer. Jour. Science,* Vol. 7, 1899, pp. 249–263.
6. ————Drumlins of central and western New York. *N. Y. State Museum Bulletin* 111, 1907.
7. ————Glacial waters in central New York. *N. Y. State Museum Bull.* 127, 1909.

8. ———The Rochester canyon and the Genesee River base levels. *Proc., Roch. Acad. Science,* Vol. 6, 1919, pp. 1–55.

9. ———The Pinnacle Hills, or the Rochester kame-moraine. *Proc., Roch. Acad. Science,* Vol. 6, 1923, pp. 141–194.

10. ———Geologic history of the Genesee Country; in *History of the Genesee Country,* Vol. 1, 1925, pp. 15–110.

11. ———Geology of western New York. Rochester, November 1925. 62 pages, 37 plates.

12. A. W. Giles. Eskers in vicinity of Rochester, N. Y. *Proc., Roch. Acad. Science,* Vol. 5, 1918, pp. 217–223, plates 13, 14.

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THE DANSVILLE VALLEY

AND

DRAINAGE HISTORY OF WESTERN NEW YORK

By Herman L. Fairchild

University of Rochester

CONTENTS

Introduction

The handsome valley which holds the village of Dansville is unexcelled among the many beautiful valleys of central and western New York. All of these valleys have been carved by rivers in the horizontal rock strata. As the Dansville valley today has no river, only the weak and ineffective Canaseraga Creek, evidently there is something peculiar and anomalous in its history. The river which produced the valley is non-existent, and apparently became extinct long ages ago. What force, event or cataclysm suppressed the river? Can we, from the geologic record, unravel the story of the unfortunate river and learn its life-history; its origin, relations and disappearance? The search will involve the drainage history of all the western half of New York through the millions of years of geologic time. So the valley is an appropriate title or text for an essay on the evolution and history of the drainage and the valley topography of western New York.

The directions of the present stream flow in New York are diverse, inconsistent and contradictory.[1] And when we include some old and capacious valleys which have lost their producing rivers the complexity is greater. The mature and splendid Dansville Valley belongs in the latter class. It is the record of an ancient and far-extended phase in the development of the New York valleys which ended with the Glacial Period.

Rivers are the valley-makers. In regions of horizontal rocks no other agency can produce valleys. In regions of disturbance and wrinkling of the earth's surficial crust some valleys are produced by dislocation, or by the down-folding, of the rock strata. But in central and western New York the strata are practically undisturbed and horizontal. The slight dip or southerly down-slope, averaging perhaps sixty feet per mile, is negligible in this study of the valleys.

All the valleys of western New York were carved in the horizontal strata by stream erosion, with the co-operation of destructive atmospheric action on the valley walls. And the process is yet active and must continue while water runs down hill and can find dry land on which to flow.

It is evident, therefore, that for the origin of the Dansville Valley, as for other capacious valleys without rivers today, we must search in the past history of the region for an ancient river of sufficient erosional power.

For this study the reader should have in hand the following sheets of the New York topographic map: Caledonia, Honeoye, Canandaigua, Nunda, Wayland, Naples, Canaseraga, Hornell and Bath. Plate 82 is a reduced map from the last six of these sheets.

[1] Turning to an atlas the reader will see the Genesee River flowing north entirely across the State; the Finger Lakes draining north and then east by the Seneca River; the Allegany finally turning south; the Chemung branches flowing southeast; the branches of the Susquehanna flowing southwest; the Tonawanda north and then westward; with minor streams in all possible directions.

DRAINAGE AREA OF THE PRE-GLACIAL DANSVILLE RIVER

The broken line is the present divide between northward and southward stream-flow

Stages in the Drainage Evolution

The history of stream work in New York, or the development of the valleys, is divisible into four fairly distinct geologic phases. They may be briefly described as follows:

(1). The original, primitive, stream work which was initiated when the ancient sea-bottom, of oceanic deposits, was lifted up to become dry land.

(2). The slow changes in direction of the river flow, produced by the adjustment of the streams to the unequal resistance (to erosion) of the rock strata.

(3). The blocking of drainage and final extinguishing of all the streams by the irresistible invasion of a continental ice sheet, the Quebec glacier.

(4). The present, Postglacial, renewal of drainage, but with greatly changed and inconsistent directions of flow.

Between the first and second stages there was no separation. Through many tens of millions of years the early drainage slowly changed into the second stage. The third stage came more promptly and lasted many scores of thousands of years. The fourth, or present-time, phase has been here only a few tens of thousands of years.

The Dansville valley was eroded in the Devonian sandstones and shales during the immensely long second stage. The ruthless work of the glacier, in the third stage, robbed the valley of its great producing river, and filled the upper stretch with rock-rubbish or glacial drift. The valley is a superior example of the evolution of western New York drainage, as its story illustrates all the phases and vicissitudes in the geologic history. It is necessary to describe the several stages with some detail.

Stage 1. Primitive Stream Flow

The western half of New York was slowly lifted out of the interior ("epicontinental") sea in very ancient geologic time. The rise was progressive from north to south. The northern district (Canada) emerged first, and the continued rise, with many minor ups-and-downs, forced the limit or shoreline of the oceanic waters southward into Pennsylvania.

The earliest rivers on the newly exposed land surface flowed southward into the receding ocean, and their courses were extended as the land rose and the sea retreated.

For this original or primitive drainage the physiographers apply the term "consequent."

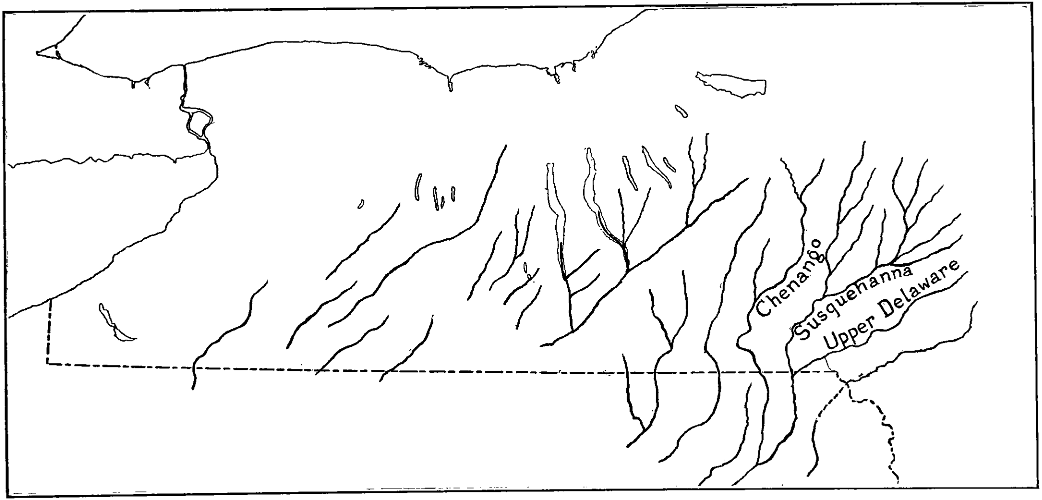
At that early stage there was no Ontario basin, nor Mohawk valley, but an unbroken south-sloping plain extending from Canada to Pennsylvania.

Most of that very ancient (Paleozoic) drainage is obliterated or obscured, but fortunately, a few existing valleys appear to be inheritances from that earliest drainage. The upper branches of the Susquehanna river lie in valleys with southward or southwestward direction, and are regarded as descendants of the primitive flow. Passing eastward these main branches are Otselic, Chenango, Unadilla, Susquehanna and Schenevus. The two upper branches of the Delaware river apparently belong to the primitive drainage.

The original streams, now partially represented by those just named, must have had their sources in the district now occupied by the Adirondack mountains. Their headwaters were cut off by the subsequent development of the east-leading Mohawk valley. In physiographic lingo the primitive, consequent rivers were beheaded by the transverse development of the "subsequent" Mohawk valley, which valley therefore belongs in the second stage of the drainage history. Perhaps some of the streams now flowing southward from the Adirondacks into the Mohawk may be descendants of the original Susquehanna headwaters.

Judging from the general direction of the Susquehanna and Delaware tributaries, and from some older abandoned valleys, (plate 83) the uptilting of the continent which accompanied the primitive drainage, and which was continued later, appears to have been in a general way from northeast to southwest. Some relics of that earliest river-flow are suggested in the wide valleys with southwestward trend that have been abandoned by the streams which produced them. For example, the capacious valley from De Ruyter (Madison County) past Cortland to Freeville (Tompkins County) holds no continuous or effective stream. Other illustrations are suggested in plate 83, which maps the more striking valleys of this class.

It must be realized that the land surface of that early time is not at all the present surface. Atmospheric decay and stream erosion have removed some unknown thickness of rock from all the uplands, while the valleys have been deeply intrenched. The rivers may now be flowing 1,000 or 2,000 feet below the level of their ancestral streams.



LINES OF VERY ANCIENT DRAINAGE

STAGE 2. REVERSAL OF DRAINAGE

Plate 84 depicts the supposed drainage of central and western New York after the flow, through many millions of years, had been radically changed in direction. This very remarkable change was produced through the control exercised by the rock strata in which the rivers sank their channels. During the long geologic ages the continent had risen, probably a few thousand feet, and the enlivened ("rejuvenated") rivers were subjected to an influence other than gravitation. This factor was the character of the rocks, not only of the superficial strata, but especially of the underlying and deeper strata which the down-cutting streams encountered. Streams in weak or less resistant strata had erosional advantage over the streams which lay in harder or more resistant rocks. The difference in resistance to decay and to erosion of the rocks in different areas, and even of the same strata in different directions, compelled an adjustment of the stream lines. Eventually this resulted in a complete reversal of the direction of stream flow in all of western New York.

To explain this singular change requires a brief description of the rock strata, or the stratigraphic geology. All the rocks of central and western New York are the consolidated sediments which were laid down on the sinking floor of the shallow inland seas. These are sandstones and shales, composed of sand and clay washed in from adjacent regions of dry land, and limestone, produced from the lime shells and skeletons of marine life.

It so happened that the great thickness, thousands of feet, of the rocks which outcropped at the surface along the northern belt, next to Canada on the west and the Adirondack area on the east, were relatively weak and non-resistant.[2] They were shales, which are easily eroded by atmospheric decay, storm-wash, and stream erosion, and limestone which is soluble in atmospheric or other water charged with carbonic acid. The rocks of the middle belt, and especially of the southern belt, next to Pennsylvania, are more resistant, being mainly sandstone.

While the primitive southwestward-flowing rivers were intrenching themselves in the rising land their east-and-west tributaries that

[2] Tables, maps and descriptions of the New York rock strata, in their vertical succession and geographic display, are given in publication Nos. 19 and 20 of the appended list of writings.

were lying in the northern belt of weak strata, had great erosional advantage. Eventually these east-and-west flowing streams were able to unite in one great river, with probably westward flow. This "subsequent" river captured all the streams flowing south from Canada, diverting that flow westward to the Mississippi. This master stream we call Ontarian River. During the long geologic eras (Mesozoic and Cenozoic) of many million years, this great river, with the aid of the atmosphere, produced the vast Ontario valley. The continent then stood much higher than today, for the bottom of Lake Ontario is now 500 feet below sea level.

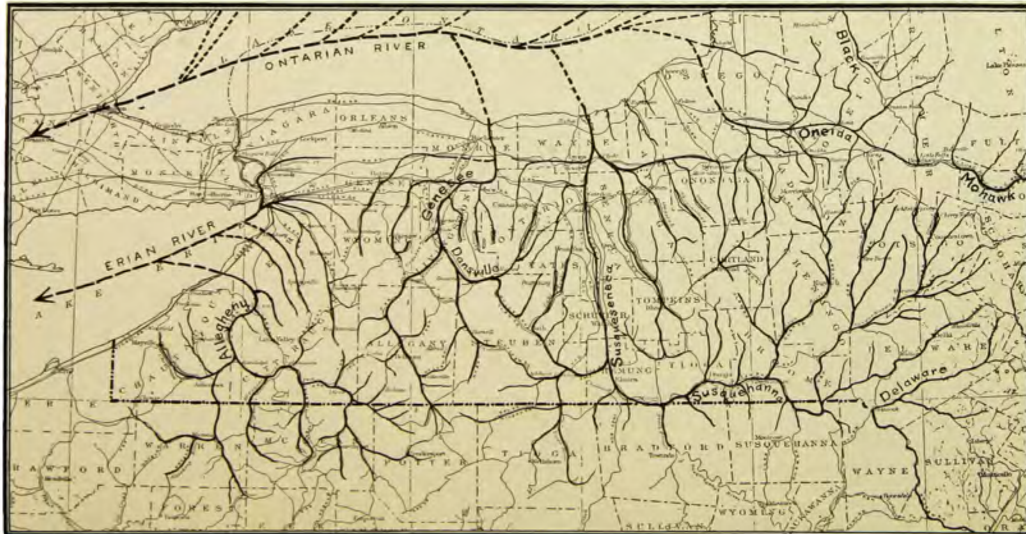
Probably contemporary with the Ontarian river the Mohawk river was developed in similar manner, and diverted the Adirondack flow eastward, as already noted.

Another river system, called Erian, carved the shallow basin that now holds Lake Erie.

Of course the valley of the Ontarian river had a southern wall, down which tributary streams flowed northward. As the Ontarian river deepened and widened its valley its southern tributaries were enlivened, and correspondingly deepened their channels. And as they developed their valleys their headwaters gnawed back (southward) into the hard uplands of the southern belt of the State. Before the Glacial Period (close of the Tertiary) the north-flowing tributaries of the Ontarian and Erian rivers had taken possession of all of central and western New York, and a wide belt of northern Pennsylvania. The Genesee river is a clear example of that northward flow, as it was able to resist the efforts of the ice sheet to wholly block or divert it. With the Dansville valley the glacier was successful, entirely suppressing the river and largely obscuring the former drainage of the district.

West of the upper tributaries of the Susquehanna the direction of flow in New York was practically reversed, turned from southward to northward. It may be incorrect to say that the individual rivers were reversed in direction, but the drainage was reversed by creation and substitution of new north-flowing streams. Probably some of the valleys of the earlier drainage were occupied by the later flow. Physiographers call such reversed drainage "obsequent."

This history explains the origin of the valleys of the Finger Lakes, which are part of the most remarkable series of parallel valleys in the world. These valleys, with or without lakes, are named, passing from west to east, Tonawanda, Oatka, Genesee,



LATE TERTIARY, PRE-GLACIAL, DRAINAGE OF WESTERN NEW YORK

Dansville, Conesus, Hemlock, Honeoye, Bristol, Canandaigua, Flint, Seneca, Cayuga, Owasco, Skaneateles, Otisco, Onondaga, Butternut, Limestone and Chittenango.

The map of Tertiary or Preglacial drainage, as shown in plate 84, requires little explanation. It will be seen that the Susquehanna waters were carried west and then north through the present Seneca valley. We might call that ancient river the Susqueseneca. The story of that river has been told in publication No. 18. The Allegany system drained north into the Erian river. Only the valleys of Canandaigua and Keuka retained their original southward flow, the former being tributary to the Dansville river, while the Keuka drained into the Chemung-Susquehanna.

The three master streams of this reversed (northward) drainage were the Susqueseneca in central New York, and the Dansville-Genesee and the Allegany in the western area.

During this stage of northward drainage, in Tertiary time, the control of stream flow by the rock formations produced not only the great Ontario valley and its north-flowing tributaries, described above, but also important, though subordinate, east and west flow.

The "Ontario Plain" is the wide lowland between the scarp or north edge of the Allegany plateau and the shore of Lake Ontario, being some 30 miles broad. On this plain three rock formations (plates 85, 86) influenced the drainage. These are two limestones and an intervening shale. The Niagara (Lockport) limestone outcrops to form the "Big Ridge," which stretches from Rochester westward to Niagara Falls. Beyond the Niagara River it is yet stronger and forms the "Mountain" at Hamilton, Ont. The Onondaga limestone lies in a belt from Syracuse to Buffalo.

Between the two limestone outcrops the thick and weak Salina shales, which contain the salt and gypsum of New York, have been eroded so as to produce an effective, though not conspicuous, east and west depression, about 15 miles wide. In this depression a lower portion of the Dansville-Genesee river flowed eastward for some 12 miles, and then in northward flow excavated the Irondequoit valley. It is important to note that only one other strong valley cut across, or breached the Niagara limestone. This is the Sodus Valley, which carried the Susqueseneca river. Plate 84 shows how these two master rivers gathered all the water of central New York. This map also shows the dominating control, east and west, exercised by the Salina depression.

This extremely long era of northward drainage into the Ontarian River, with complete mastery of central and western New York, came to end at the close of the Tertiary Period with the oncoming of the vast continental ice sheet.

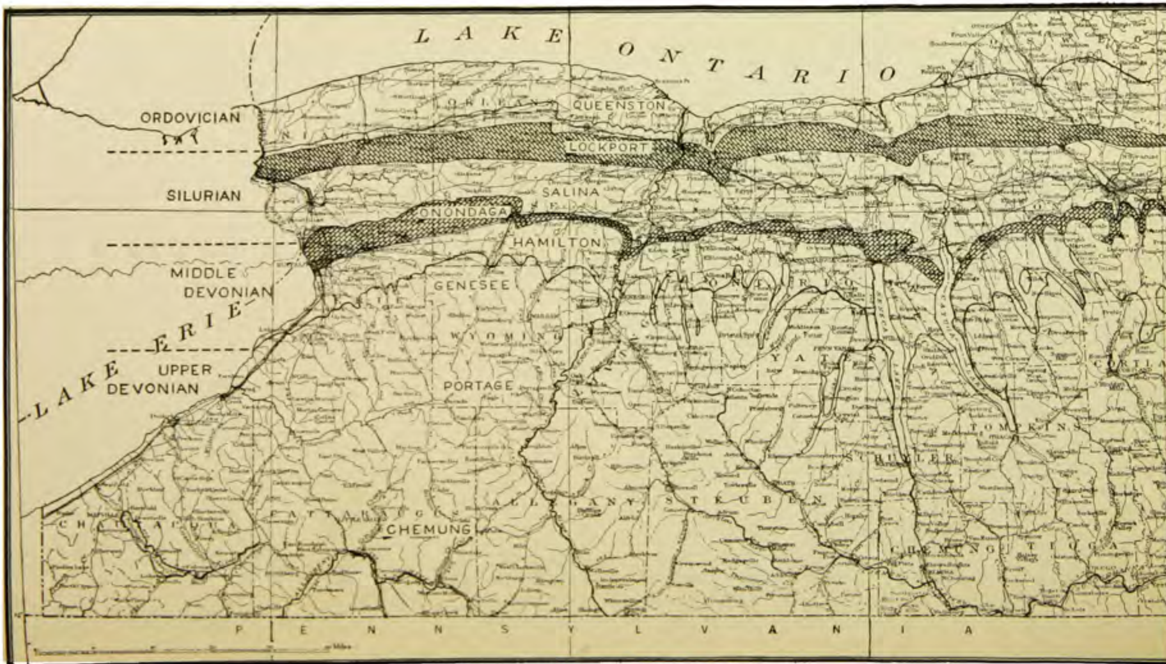
The Dansville River. The very wide and deep valley at and north of Dansville village could never have been produced alone, or as a distinct, individual valley. It is only a portion of some once far-extended, but now dismembered river course. The river which carved the valley required the drainage from a large territory, and must have had either a long course or heavy tributaries.

The Dansville Valley, it should now be understood, was developed during the long, long stage of northward drainage into the Ontarian-Mississippian flow, by one of the great obsequent rivers. Of the precise manner of its origin, and of the early phases or events in its history, we may not be confident. But of its mature character and its relations we have some good suggestions. Plate 84 gives the writer's conception of the relation of the river to the neighboring stream systems.

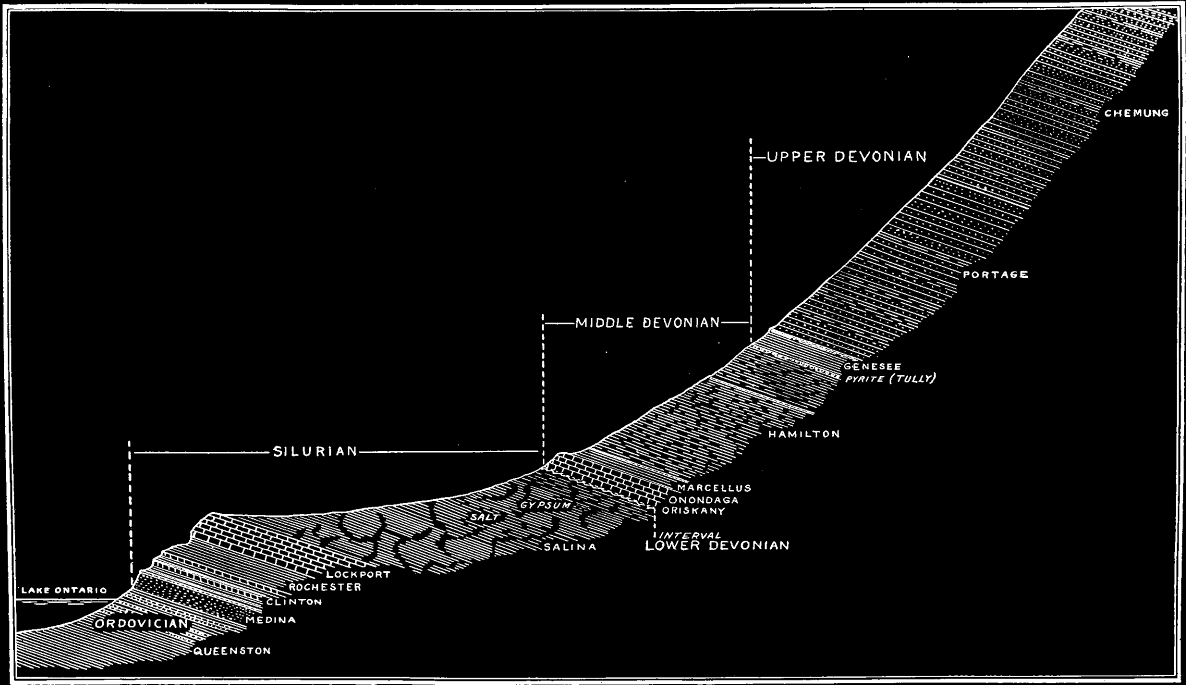
South of Dansville the great valley has been blocked and filled by glacial drift and lake deposits. But the more open valley northwestward, having only the deeper part filled with lake sediments, reveals what a splendid valley it must have been in its prime, with a noble river in rapid flow between the lofty slopes. The present smooth appearance of the curving valley walls has been produced by the rubbing action of the deep ice sheet.

North of Mt. Morris the ancient valley is occupied by the Genesee river, and we call it the Genesee valley. But before the ice age, judging from the forms of the valleys and their relations, the Dansville was the trunk stream and the Genesee was its tributary. But in glacial time, by local drift filling and blockade, the Genesee was diverted into a new course, producing the canyons at Portage and Mt. Morris. Before the ice age it probably passed northeast from Portageville through the valley at Nunda, and joined the Dansville in the neighborhood of Sonyea. From there to north of Avon the flow was the same as today. But at some point north of Avon it is thought that the river turned eastward, though the Salina depression, now drift filled and obliterated, to near Fishers. From there it passed north by the capacious Irondequoit valley. (Plate 84.)

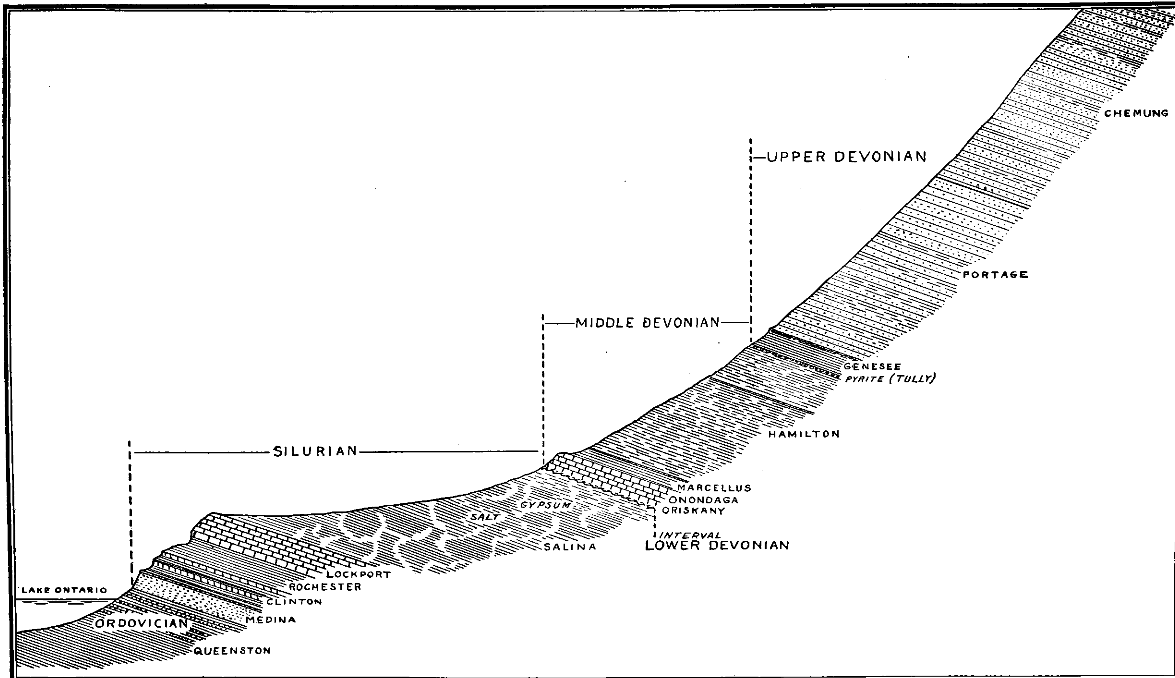
The Dansville River appears to have had its main branch, or stem, in the Canandaigua Valley. With south flow in that valley



AREAL, OR SURFACE, GEOLOGY OF WESTERN NEW YORK



ROCK STRATA OF GENESEE VALLEY
Vertical north-south section; looking eastward



ROCK STRATA OF GENESEE VALLEY
Vertical north-south section; looking eastward

it turned southwest through the valley, where, on the drift filling, there now stand the villages of North Cohocton, Wayland and Perkinsville.

The Dansville system included the Cohocton valley nearly to Bath, and the Canisteo valley to Adrian. The Canaseraga was a tributary of the Canisteo branch. The reader may suggest names for these extinguished branches which will not confuse with names of present drainage.

Following the supposed course of the Dansville river as outlined above, the distance from the middle of Canandaigua lake around by the circuitous course to the middle of Lake Ontario is about 111 miles. The bottom of Canandaigua lake is 424 feet above ocean, and that of Ontario quite 500 feet below sea level. Ignoring the possible drift filling in the lakes this gives a drop for the Dansville-Genesee river of 924 feet, and an average gradient of 8.3 feet per mile. This is a rather steep slope for a great river, and gave great erosive power.

Stage 3. Glacial Diversion

History of the Ice Invasion. The continental ice sheet was nourished by snowfall, and from its central area in southern Quebec it spread by its own weight, as a plastic body. Melting was constant at the margin of the glacier, but as long as the spreading flow exceeded the marginal melting the ice sheet enlarged, until finally it covered all of New England and New York.

During the slow oncoming of the resistless glacier all the north-flowing drainage (Plate 84) was blocked and eventually extinguished. During the earlier phase a series of glacial lakes, ice-impounded waters, were held at successively higher levels in all the north-sloping valleys. All the glacial and drainage phenomena produced during the ice invasion are destroyed, or buried, or are at least indistinguishable.

The ice sheet finally covered all of the State, and then lingered for some time. Eventually, due to undetermined climatic and physiographic factors, the ice cap slowly waned and the margin receded, in the reverse of its invasion. All the various glacial phenomena, the sheet of till, the moraines, kames, eskers, etc.,[3] and

[3] For glossary and definitions of glacial terminology, see pages 144–148 of this volume.

the indirect effects, as the glacial lakes and their outlet channels and deposits, are assigned to the retreatal or withdrawal phase of the glacial process.

The story of the glacial waters in New York has been told in numerous writings (see the appended list). The beaches of the glacial lakes and the channels of the glacial rivers are witnesses of the ice age drama.

When the receding front of the ice sheet reached the east and west Salina depression, described above, the copious flow of water from the melting ice, with the added drainage from the exposed highlands on the south, was compelled to use that lower ground for the eastward escape to the Mohawk-Hudson. The channels cut by the glacial ice-border drainage are conspicuous and interesting features. These channels are mapped in paper 9, plates 1–5.

Effects of Glaciation. The work of the Quebec ice sheet over New York was partly erosional, but chiefly depositional, or constructional. Being heavily loaded in the basal layers with the rock-rubbish that it had accumulated, and pushing uphill, it had slight effect in deepening the valleys, which are all of stream production. But on the valley walls, especially the valleys trending in the direction of ice movement, it had sufficient erosional effect, by a sand-papering process, to produce the smooth surfaces of the graceful convex slopes so conspicuous in the Dansville Valley and in all the parallel valleys of central and western New York.

The glacial deposits were imposed on the old preglacial surface of the land. On the uplands the old and the new topography can usually be discriminated, but in the valleys the ice and lake deposits have mostly buried the ancient forms.

The greater work of the glacier was the piling of its drift burden in the valleys, with the consequent diversion of the streams, and the construction of the very singular and interesting Drumlins, Kames, Eskers and frontal Moraines. As drumlins and eskers do not occur in the Dansville Valley and are described in former writings they may be here omitted. But moraine and kame-moraine deposits are conspicuous.

The irregular topography, mound and basin, traversed by the highways and railroads south and east of Dansville is that of a frontal moraine. It is part of the belt of the heaviest moraine in the State, called the Valley-Heads moraine, being the massive filling which forms the head and drainage divide, or stream parting, in all the Finger Lakes valleys. (Plate 88). This glacial filling in the valley south to Rogersville, and southeast to Perkinsville, has unusual character due to a complex history. It was not deposited freely and openly in the atmosphere, but was laid down under the water of a glacial lake, which is described below. Subsequently, after the ice front had receded some distance, but while the lake waters yet existed, or were lowering, the streams from the uplands on three sides swept in detritus that partly buried the ice-laid drift under water-laid sands and clay. And after the lake disappeared the stormwash and the brooks flowing across the area from the south and east have eroded the deposits, producing the many stream

Figure 1. DANSVILLE VALLEY
Looking northwest from roof of Jackson Hotel and Health Resort

channels which converge towards the village. The present peculiar topography, shown in plate 87, is the complex product of glacier, lake, stream and atmospheric action.

The work of the ice sheet has been of distinct human benefit in New York, and especially in the Genesee country. On the northerly upland belt the drift sheet ("till") is rich in mineral matter that is plant food, derived from the rocks of Canada and the Adirondacks. On the lower ground of the Ontario lowland, and in the valleys, the commingled ice, lake and stream deposits are famous for fertility. The superior agricultural advantages of western New York are largely direct or indirect effects of the glaciation.

To the blockade of moraine drift in the deep preglacial valleys of river erosion, in stage 2 of the drainage history, the Finger Lakes are due; as are the valley plains in some of the parallel valleys where the postglacial lakes have been replaced by inwash and vegetable growth.

Another effect of the ice sheet, inconspicuous but geologically very important and interesting, was the overweighting of the land which it covered and the consequent depression of the earth's surface. Since the removal of the ice cap the land has risen, slantingly in New York. At Dansville the theoretic amount of postglacial

Figure 2. DELTA OF STONY BROOK
Southern point. Looking north

land uplift is about 160 feet. At Rochester it is 250 feet, and on the international boundary, west of Lake Champlain it is 740 feet. (Papers 11–14.)

Glacial Lakes. The most romantic episode of the glacial his- is that of the ice-dammed waters. During the slow oncoming of the implacable ice sheet all of the northward drainage was blocked, and a series of water-bodies of successively higher and higher levels were held in all the north-declining valleys. All the features produced by those lakes of ice-advance, and by their outflowing streams, were obliterated by the continued expansion of the glacier. But when the full-grown ice sheet was finally conquered by ameliorating conditions, and grudgingly yielded by marginal melting, the receding front in its northward retreat impounded a second series of lakes. These glacial lakes of ice recession were the reverse of the earlier series by ice invasion, as they fell from higher to lower levels, as successively lower outlets were uncovered. All the varied and interesting features of standing waters and their outlet channels belong to this phase of ice removal. The glacial lakes were the closing act of the glacial drama (paper 16).

The larger glacial lakes were the ancestors of the present Great Lakes. The present Finger Lakes are successors of the later glacial

Figure 3. MORAINE
Three miles south of Dansville. Looking south from the Bluff Point School, seen in figure 2

lakes in New York. And the glacial Lake Iroquois which occupied the Ontario basin was the last of the ice-bound waters and has left the most complete record. (Paper 15.)

The study of the glacial lake history, by tracing their shorelines and correlating their outlets, is largely a determination of elevations. And this involves another geologic factor. If there had been no change in the position or attitude of the land since the lakes existed the old shorelines would yet be horizontal, and mapping would be more simple. But such is not the case. The great and long-enduring burden of the ice-cap seriously depressed the land. Since the ice disappeared the land has risen, in only partial recovery of its preglacial attitude. It appears that the downthrow and the recent uplift have been somewhat proportional to the thickness and weight of the ice sheet; and consequently in New York the land rise has been a tilting, or an upslant northward, amounting to over two feet per mile. Hence in tracing lake shores, as through the Dansville Valley, one must recognize the land deformation, rising northward and declining southward. In the Dansville district a correction of 2.25 feet per mile should be used.

The glacial lake history of central and western New York has been told in several publications (4, 6, 9, 10, 21) and that of the Genesee drainage basin in papers 2, 8, 19. The series of Genesee lakes doubtless forms the most remarkable and complex drainage history of any district in the world.

Figure 4. FLOW CHANNELS ON DELTA GRAVEL
One and one-fourth miles east of Canaseraga. Looking southeast

In this writing it is appropriate to discuss only those glacial waters which had relation to the Dansville Valley. Several successive lakes were held in the Genesee Valley above (south of) Portageville while all of the present Dansville Valley was yet covered by the glacier. And when the ice front was piling the massive moraine south of the village a lake was held in the Canisteo Valley, which we may name Lake Hornell. The lake and stream phenomena related to the Hornell and Dansville waters are complex and involved, and the reader must not require either brevity or simplicity in their description.

The control, or outlet, of Lake Hornell was at Adrian, where the glacial outflow, and the subsequent Canisteo River, have produced a handsome canyon, in the southward flow to the Susquehanna. Before the ice age the valley at Adrian is supposed to have had a col, or drainage divide, between north and south flow; the northward stream being tributary to the Dansville River (plate 84).[4]

Lake Hornell expanded northward as the ice front receded, until it reached nearly to the site of Dansville. At that time the glacier was piling its frontal moraine in the lake waters, south of the village. At the same time Stony Brook had come into existence and was busy sweeping the abundant drift from the upland and dumping it to form a wide delta plain in the lake. This handsome lake plain lies both sides of Stony Brook Glen and is traversed by the P. S. & N. Railroad. The Bluff Point School stands on the

Figure 5. STREAM TERRACES
One mile northeast of Canaseraga. Looking north

southern point of the delta (figure 2), and commands the view shown in figure 3. The hamlet of Rogersville is on the wide plain stretching northward that was built in the earliest phase of the lake in that district, with contour elevation of 1,280 feet. The elevation of the Stony Brook delta plain is 1,260 to 1,280 feet.

The glacial history of the Canisteo Valley and the Lake Hornell may be described briefly. A glance at the Hornell sheet shows the narrow pass west of Adrian. Doubtless the channel has been deepened considerably by the Canisteo River during the many thousands of years since the pass was the outlet control of the glacial lake. The present channel is 1,100 feet, but the terraces along the valley

[4] When the former papers were written the lake history of the Canisteo Valley had not been recognized.

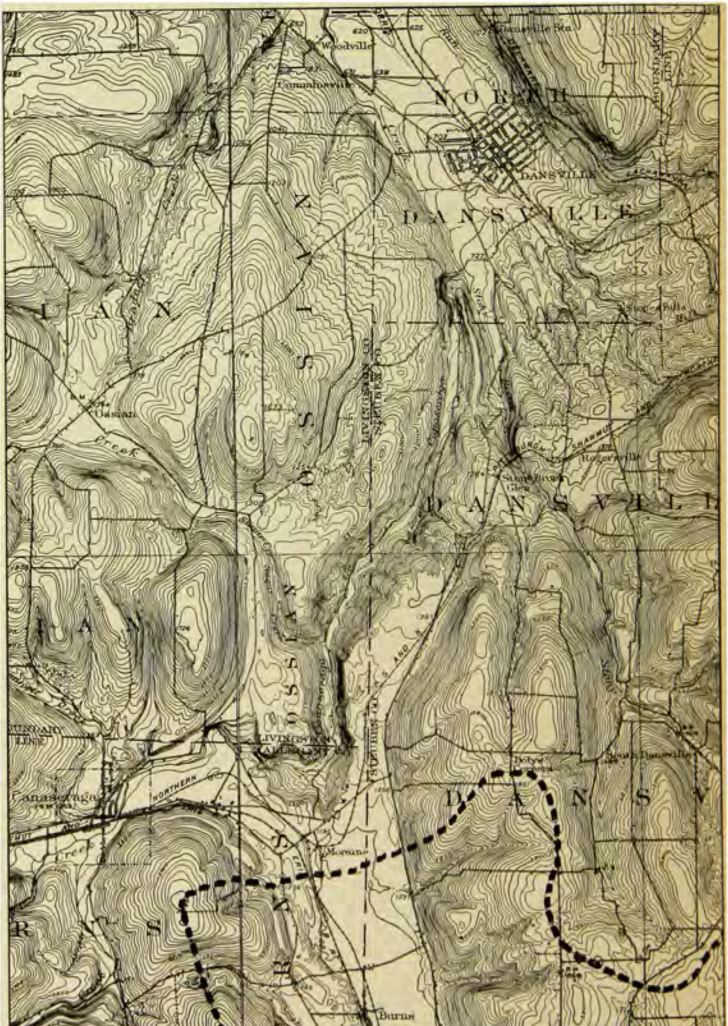
sides indicate that the lake had an elevation of toward 1,200 feet. Above Hornell the indolent stream has had slight effect in erosion of the lake-bottom plain, and above Arkport no effect at all.

The lower slopes of the valley walls have very interesting features. The last ice occupation of the valley was by a slender lobe or tongue of the glacier. Above and below North Hornell the east valley wall has very clear stream-cut terraces or shelves made by the flow of escaping water along the side of the ice lobe. The water was partly from the melting ice but was largely the flow of Carrington and Big creeks. On the face of the hill, a mile north of North

Figure 6. **RIVER BANK**
Two miles east of Canaseraga. Looking south

Hornell, at least four distinct terraces may be counted, ranging in altitude from 1,240 to 1,380 feet. These benches are suggested by the map contours. Before these terraces were made the water of Carrington Creek, and the glacial water, found higher escape behind (east of) the hill. During this phase the fine delta plain north of the hill, and south of Burden School, was built in a local glacial lake, held in by the ice lobe. As the ice barrier weakened the outflow cut the terraces on the hillslope facing the valley. Lower terraces along the valley walls, at and below 1,200 feet, were made in the open lake.

On the west side of the valley at Burns, and for three miles northward, is a pronounced kame-moraine and delta, with elevation up



TOPOGRAPHY OF THE DANSVILLE DISTRICT
Broken line is water-parting between the present north and south flow

to 1,300 feet. This deposit was piled against the ice lobe by a river pouring into Lake Hornell from the west through the Canaseraga Valley. The river was the outflow of the Portage-Nunda Lake, one of the many stages of the Genesee Valley glacial waters (paper 2, pages 438–446).

East of Canaseraga village is a splendid pitted plain, or kettled plain, toward two miles long, at 1,260 feet elevation. This was built in Lake Hornell along with the Burns filling. The pits or bowls in the plain are true kettles, from buried ice blocks, which did not melt until the lake was drained away. Probably the deposit is mainly

Figure 7. **HEAD OF POAGSHOLE**
Looking north from highway one-fourth mile north of Moraine Station

glacial with only a veneer of lake sediments. This interesting plain (figures 4–6) appears to be only a portion of a great delta plain that filled the wide valley northeast for miles. The scenic gorge of Canaseraga Creek, known locally as Poagshole (figure 7), has been excavated out of the plain. But a good remnant of the wide filling is the plain on the east side of the valley from Moraine Station north for three miles. This is traversed by the railroad and the Dansville-Hornell highway, with elevation rising from 1,200 to 1,300 feet.

With erosion of the outlet channel at Adrian the Hornell waters were gradually lowered, and at some stage, with unknown time relation to the Hornell lake, the glacial waters spread over the Dansville district. Eventually the Dansville lake became one of the long series of glacial lakes which occupied the drainage basin of the Genesee River, as noted above.

The earlier phase of the Dansville lake was independent of the Genesee valley waters. Its level was somewhat below that of Lake Hornell, its predecessor. Judging by the kettle-plain at Canaseraga village, and the levels either side of Poagshole, the Hornell waters lay there at about 1,260 feet, present altitude. Lake Dansville came into existence when the Hornell waters fell toward 1,200 feet. A portion of the floor of the outlet channel of Lake Dansville is well preserved southeast of Moraine station. For a mile north and

Figure 8. STONY BROOK GLEN
Lower fall

south, and with width of one-half mile, the ground is coarse gravel, swampy and uncultivated. The surface has a fluted, or washboard form, a characteristic effect of river flow over sand and gravel. This is the record of the latest outflow, and determines the later lake level at 1,200 feet, plus the depth of the river. The earliest outflow was somewhat higher, and the channel farther north, where Canaseraga Creek has excavated the great delta, producing Poagshole ravine (figure 7).

The glacial Genesee waters became tributary to Lake Dansville when the glacier front weakened and declined on the steep hillside a mile southeast of Union Corners (Town of West Sparta), to about 1,340 feet. Then the Portage-Nunda lake began to abandon its channel at Rosses, in the upper Canaseraga valley (Nunda sheet) and the waters sneaked around the north face of the Union Corners hill, between the ice front and the rock slope. The notches cut in the hillside are weak but distinct.

When the ice against the hill at Union Corners yielded sufficiently to let the Portage-Nunda lake blend with the water in the Dansville valley, then Lake Dansville became a full-fledged member of the Genesee lake series. And Lake Dansville existed for a long time, until the receding ice front uncovered lower escape on the ground

Figure 9. STONY BROOK GLEN
Upper fall

south of Batavia and permitted the water to escape westward to Mississippi drainage. (Papers 6, 9.)

Shore phenomena as evidence of the Dansville lake must correlate with the level of the outlet north of Burns, which is 1,200 feet. We may add five to ten feet for depth of the river, and about 29 feet more for the differential uplift of the land; and then look for the latest shore features at Dansville at about 1,225 or 1,230 feet. The terraces south of the village much higher than this figure belong to the Hornell lake, for example, the plain at Rogersville, 1,300 feet, and the Stony Brook delta.

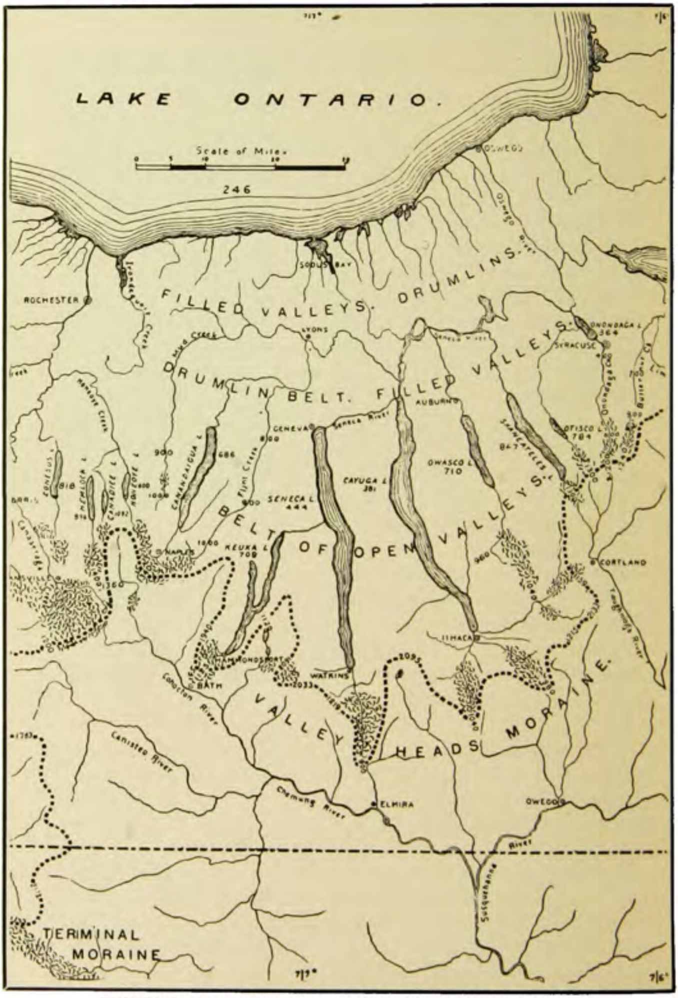
On the heavy moraine filling between Dansville and Rogersville the terracing is found at levels from 1,300 down to 700 feet, representing the lowering of the waters to much below the Dansville lake level. To find Lake Dansville shore features as the highest record we must go north some miles, to where the valley ice lobe had covered the land slopes until Lake Dansville was in existence. Such shore terraces are found northwest of Reeds Corners at about 1,220–1,230 feet.

Succeeding Lake Dansville was a long succession of glacial lakes in the Genesee valley, with changing levels, up and down. The story has been told in papers 2, 4, 9, 10, and it is too long and involved to be here repeated. The Genesee waters with elevation above 600 feet flooded the Dansville valley, and the lower terraces on the valley walls, the deltas of creeks and brooks, were made in the inferior waters. Two of the later and important lakes were Warren and Dana, the former tributary to the Mississippi and the latter to the Mohawk-Hudson. Between Dansville and Mount Morris the Warren plane is figured at about 820 feet; and the Dana level is always 180 feet lower than the Warren. It may be difficult, but interesting, to discriminate these levels from among the delta terraces on the walls of the valley. Well developed deltas occur east and north of Groveland Station, and west of Groveland, on the streams flowing down the east wall of the valley.

There are other interesting features in the Dansville region. One is the shut-in plain at Ossian, at 1,340 feet. This appears to be a filling of a small local lake which was held in the triangular hollow between the hills for a brief time. The Ossian valley collected a large volume of the glacial drainage, and this found escape southeastward by the valley now occupied by Sugar Creek. The outflow helped to build the extensive delta plain extending for three miles northeast of Canaseraga village. This plain is part of the great delta filling described above.

The Pokamoonshine Gulf, four miles northeast of Dansville, is a singular deep cut across a high ridge. Its explanation can be found only in the glacial history. Probably a notch in the ridge existed there before glacial time. The elevation at the head of the Gulf is 1,520 feet. The probable explanation is, that when the waning ice lobe in the Dansville district was pressing against the hill west of Wayland the notch became the outlet for the waters in Carney Hollow, which in their eastward flow deepened the notch and produced the present gulf.

The wide valley east from Perkinsville to North Cohocton, and then south as the Cohocton Valley, has its own complex and inter-



PHYSIOGRAPHIC BELTS OF THE FINGER LAKES DISTRICT esting history. That it was occupied by standing waters is proven not only by the smooth plains of sand and clay, but also by the beds of marl. The marl is an accumulation of lime by the work of lime-secreting plants (Chara) in quiet calcareous waters.

The lake history in the Wayland valley is tied in with that of the glacial waters in the Cohocton valley. The plain west of Atlanta and North Cohocton was partly contributed by the stream which carried the overflow of the highest glacial waters in the Canandaigua Valley, the Naples Lake. (1, pages 361–364.)

The very handsome Cohocton Valley contains many very interesting features and deserves special study. Especially notable are the deep and strong channels on the west wall of the valley, a mile west of Cohocton village, which were cut by glacial waters.

Buried Dansville Valley. The deep filling of glacier and lake deposits in the stretch of the ancient valley from Dansville to Naples has so changed the appearance of the country that the river history and valley topography might not be recognized. But a glance at the Wayland and Naples topographic maps will show that the deposits occupy only the bottom, or deeper section, of the old valley. The valley walls of rock strata rise as hills 500 feet above the filling, and the outline of the great valley is in general very clear.

The morainal stuff left in the valley by the ice sheet has been smoothed and covered by the subsequent glacial lake waters, as proved by the sands, clays and marl. These are described below.

Without many deep boring to reveal the buried rock topography, we cannot be sure of the depths of drift in the old valleys. A crude guess is made by using the supposed slope of the rock bottom of the valley. By comparing the known surfaces of the land along the course of the Dansville river with the supposed line of the river bottom, from the bed of Canandaigua lake to that of Lake Ontario, some suggestion of the depth of filling is obtained.

The bed of the ancient river probably was not uniform in slope, because the river cut across the edges of two heavy limestone formations, the Onondaga, somewhere south of Avon, and the Lockport (Niagara), somewhere in the Upper Irondequoit valley (plate 85). With some allowance for this the depths of drift figure as follows: The greatest depth is at the divide near Perkinsville where the surface elevation is 1,380 feet. The old river bed is theoretically about 300, which gives 1,080 feet of drift. At Wayland it is about 1,000 feet, and at the divide north of North Cohocton about the same. Under Dansville village the drift is estimated at about 400 feet,[5] and under Mt. Morris about 370. Under the swamp plain at the head of Irondequoit Bay the filling is between 500 and 600 feet. Sometime, somewhere these rough theoretic estimates may be checked by the drill and the true depths found. The drillers should not mistake heavy glacial bowlders for the bed rock.

Stage 4. Present Diverted Drainage

Any geographic map of New York State will show, when compared with plate 84, the Preglacial drainage, the remarkable changes produced in river-flow by the obtrusive interference of the Quebec ice sheet.

The dominating physiographic feature of ancient time was the great Ontario Valley, with its Ontarian River, and today the valley with its lake remains as the greatest controlling factor, although it has lost a large part of the contribution by the southern tributaries.

The only one of the ancient rivers which has successfully resisted the destructive efforts of the glacier is the Genesee. Although it has been diverted into new channels, for most of its course below Portageville, it has retained its northward direction.

The present varied and irrevelant directions of stream-flow are due to glacial interference, first by compelling new flow, and later by the drift blockades.

The chief effect of the moraine fillings and drift blockade was the turning of northward drainage into southward. The Preglacial drainage headed in northern Pennsylvania. The construction of the Valley Heads moraine (plate 88) turned the upper or southern portions of the northflowing streams back to southward. In other words, the principal drainage divide was shifted from northern Pennsylvania into central New York, as shown by the broken line in plate 88.

Local diversion due to moraine dams have compelled streams to find new courses, thus producing the young and steep-walled channels, like Niagara, Portage, Rochester and Oswego canyons, and the numerous ravines or glens in the smaller streams. Stony Brook Glen is a fine example (figures 8, 9).

The filling of considerable stretches of the old valleys by drift accumulation has been more effective where the valley lay athwart

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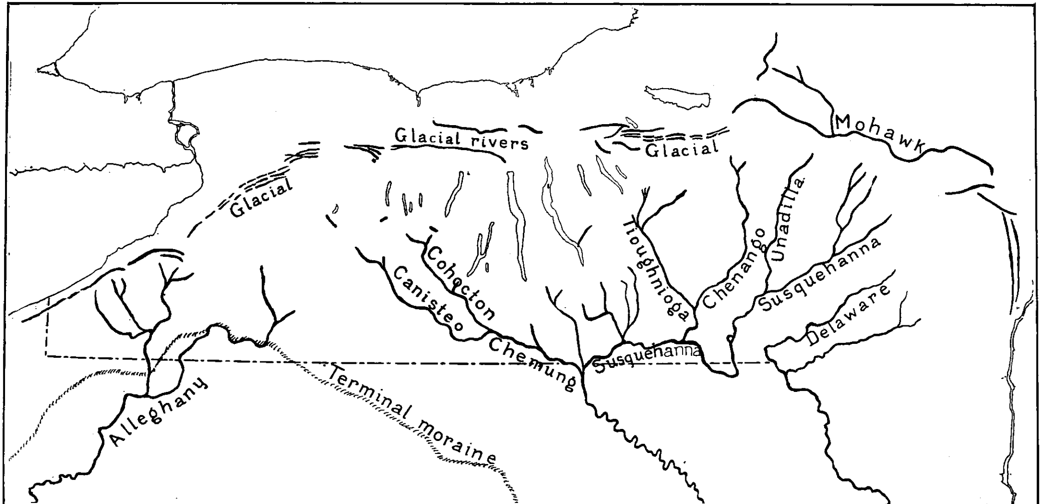
[5] Since this paper was written it is learned that a well, three miles below Dansville, was sunk 450 feet without reaching rock.



GLACIAL DRAINAGE

the direction of ice movement. Examples in the Dansville and Genesee have been described above.

The broad east and west depression on the outcrop of the Salina shales (plate 85) which had been effective in Preglacial time in turning the flow of all central and western New York into the two trunk streams, the Genesee and Susqueseneca, has retained its influence. Today the flow is mostly concentrated in the Genesee and Oswego rivers. The east-flowing glacial rivers produced channels which the present secondary streams partially follow. The principal west-flowing streams in the Salina belt are the lower portions of the Tonawanda and Honeoye creeks. The eastflowing streams are the Black and Oatka creeks west of the Genesee River, and the Ganargua Creek and Seneca River in central New York.

The most striking glacial effect on the drainage has been the production of new rivers. Plate 89 shows the forced glacial drainage and the newly created rivers. The chief examples of the latter are the Canisteo, Cohocton and Tioughnioga rivers. The Cayuta Creek, joining the Susquehanna River at Waverly, is an example of the smaller new streams.

The new, or Postglacial, rivers were produced by the piecing together of old and previously independent stream courses. The glacial waters being forced into some southward escape took possession of available valleys, and by cutting down the minor divides produced extended streams, some of which have survived, as named above.

In résumé of the drainage history:—all the drainage of western-central New York was originally southward. Then, under rock control and the development of the Ontario basin it was all turned northward. The invading ice sheet turned it again southward, and then entirely extinguished it. The removal of the ice sheet has left the older flow divided, part northward and part southward, with tributary in various directions.

Post-Glacial Erosion; Scenic Features

The elevation of the continent is so much lower that it was in Tertiary or Preglacial time that the stream gradients are reduced. Postglacial time has been too brief to permit important adjustment of the drainage by rock control. The newness of our present drainage is proven by the many canyons of large rivers, as Niagara, Rochester, Portage, Mount Morris and Oswego, and the innumerable ravines, as Stony Brook, Watkins, Montour, Taughannock, Ithaca and scores of other beautiful glens.

Much of the existing drainage is yet in the infantile stage of drainage evolution. Some of the larger streams have attained the youthful stage in their new courses, illustrated in the canyons and cataracts named above. It will be understood that any stream channel with steep walls is young, and indicates some recent change in flow, either in place or in volume. Given time and the walls crumble under atmospheric decay, and the valley widens, especially in weak shales and sandstone like those of all the streams of central and western New York.

The multitude of lakes and lakelets in the northern country prove interference with the drainage, for bodies of standing water are not normal to free-flowing streams. Before the Ice Age probably there were no lakes in all of eastern America.

For all of our peculiar and romantic scenic features we are indebted to glaciation. We may add this to our soil fertility as credit against having been for ages, like present Greenland, under the relentless ice sheet. Without glaciation we should have had only the valley and mountain forms, like southern Pennsylvania.

Glacial geology has a romantic interest that appeals to the lovers of the out-of-doors. And its educational value is not surpassed, though not appreciated, among the many subjects of the schools.

Future Changes

With a far look ahead, for some millions of years, and in attempt to forecast geologic future of our drainage, we can judge only by the long past. If northeastern America should again be lifted by the interior geophysical forces, perhaps one or two thousand feet higher, all the streams would be greatly enlivened. The Great Lakes, and all the lesser lakes, would probably disappear by downcutting of their outlets. The drift fillings in the valleys would be largely removed. The mature drainage would largely restore that of Tertiary time, plate 84. But probably Niagara, Genesee, and Oswego rivers would retain their courses, developing very deep and wide valleys. Perhaps the Irondequoit and Sodus valleys would again carry heavy streams. The fate of the Dansville Valley is not evident. From Naples to Dansville the drift filling is massive, lying high at the head of divergent flow. Probably Canandaigua Valley would retain its northward flow, while either that or the Cohocton River might eat back, headward, and possess the Wayland-Perkinsville district. The Dansville Valley proper would probably remain tributary to the downcutting Genesee.

The general effect of land uplift would be the increase of topographic relief, as deepening the valleys would exceed the wastage of the hill and mountain tops. With long permanence in elevation the erosion of the uplands would reduce the relief.

If the land merely retains its present attitude for indefinite geologic time the changes in the drainage would be similar in kind to those described above, but in much less degree and very slowly.

If on the other hand the continent should sink below its present attitude all the drainage would be retarded, and in many valleys deposition would replace erosion. The uplands would be eroded away faster than the valleys deepen, and so the topographic relief would be reduced and softened, and the large region approach a near-plain or peneplane.

If the sinking should go far enough to carry the area under the sea it would merely repeat the conditions which existed when our rock strata were forming. A fall of only 700 feet would drown the Rochester plain and flood the Dansville Valley. That would be a small vertical change compared with the thousands of feet in up-and-down movement of the region in the past.

Any of these suggested changes are possible in the future, and one of them is probable if not inevitable. The reader can make a choice without fear of consequences.

List of Writings

The following list is of papers bearing more or less directly on the subject of the present writing. Titles of publications relating to the rock strata and the economic products will be found in number 19, and a more complete general list in number 18. Papers having immediate relation to the drainage history are numbers 8, 9, 15, 18.

1. H. L. Fairchild. Glacial lakes of western New York. *Geological Society of America*, Bulletin VI, 1895, 333–374.
2. ———Glacial Genesee lakes. *Geol. Soc. Amer.*, Bull. VII, 1896, 423–452.
3. ———Kettles in glacial lake deltas. *Journal of Geology*, VI, 1898, 589–596.

4. ———Glacial lake waters in the Finger Lakes region of New York. *Geol. Soc. Amer.*, Bull., X, 1899, 27–68.
5. ———Geology of Irondequoit Bay. *Rochester Academy of Science.* Proc. III. 1906, 236–239.
6. ———Glacial waters in the Lake Erie basin. *N. Y. State Museau,* Bull. 106, 1907.
7. ———Drumlins of central and western New York. *N. Y. State Museum,* Bull. 111, 1907.
8. ———Pleistocene history of the Genesee Valley in the Portage district. *N. Y. State Museum,* Bull. 118, 1907, 70–84.
9. ———Glacial waters in central New York. *N. Y. State Museum,* Bull. 127, 1909.
10. ———Pleistocene geology of New York State. *Geol. Soc. Amer.* Bull. XIV, 1913, 133–162. *Science,* XXXVII, 1913, 237–249; 290–299.
11. ———Pleistocene uplift of New York and adjacent territory. *Geol. Soc. Amer.,* Bull. XXVII, 1916, 235–262.
12. ———Post-Glacial continental uplift. *Science,* XLVII, 1918, 615–617.
13. ———Glacial depression and Post-Glacial uplift of Northeastern America. *Nat. Acad. Science,* Proc. IV, 1918, 229–232.
14. ———Post-Glacial uplift of northeastern America. *Geol. Soc. Amer.* Bull. XXIX, 1918, 187–238.
15. ———The Rochester canyon and the Genesee River base-levels. *Roch. Acad. Science,* Bull. VI, 1919, 1–55.
16. ———A nature drama. *Scientific Monthly,* X, 1920, 404–417.
17. ———The Pinnacle Hills or the Rochester Kame-Moraine. *Roch. Acad. Science,* VI. 1923, 141–194.
18. ———The Susquehanna River in New York and evolution of western New York drainage. *N. Y. State Museum,* Bull. 256, 1925.
19. ———Geologic history of the Genesee country. *The Gencsee Country,* I, Chap. 1, 15–110, Chicago, 1925.
20. ———Geology of Western New York. (Republication of No. 19) 62 pages, 37 plate, Rochester, 1925.
21. ———Geologic romance of the Finger Lakes. *Scientific Monthly,* August, 1926, XXIII, 161–173.
22. ———Geologic Story of the Genesee. *Gas and Electric News,* XIV-XV, 1926–1927.

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ABORIGINAL CULTURES AND CHRONOLOGY OF THE GENESEE COUNTRY

BY

ARTHUR C. PARKER

ROCHESTER, N. Y.
PUBLISHED BY THE SOCIETY
SEPTEMBER, 1929

TYPICAL NEW YORK POTTERY

1 and 2 are typical Algonkian pottery vessels. 3 and 4 are typical Iroquoian vessels. All are in the New York State Museum Collection at Albany. No. 4 is 10½ inches high

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ABORIGINAL CULTURES AND CHRONOLOGY OF THE GENESEE COUNTRY

By Arthur C. Parker

Director of the Rochester Municipal Museum

CONTENTS

Introduction

Fifty years ago the problem of aboriginal American cultures was little understood. A considerable number of men, it is true, examined the mounds and earthworks of eastern America and speculated upon them. Even earlier several writers had written long treatises attempting to prove that the American Indians were the descendants of the Ten Lost Tribes of Israel, while others postulated a mysterious race called the Mound Builders. This was the day of the antiquarian. His carelessly acquired specimens were called *relics* or *antiquities,* and if a qualifying expression were needed the word *Indian* was sufficient.

The excavations of E. G. Squier, A.M., and E. H. Davis, M.D., in the early 40's and the subsequent publication [1] by the Smithsonian Institution in 1847 of the record of their joint work aroused the country to some appreciation of the importance of American archeology and its vast possibilities. It was many years, however, before sufficient work had been done by trained men to make possible genuine conclusions.

For a full century at least amateur "antiquarians" have torn up Indian graves, destroyed mounds and carried away numerous evidences of the earlier occupation of the continent. Indian relics became a passion and a considerable traffic sprang up. The great firm of Tiffany and Company had its small beginnings in the sale of Indian implements and became a jewelry company only after a partner named Young added a watch repairer's table to the shop and began to sell inexpensive jewelry. Indian relics, as such native artifacts were termed, were regarded principally as curiosities. The fact that they might be important links in the study of scientific problems was entirely subordinate, or not even considered.

Thus hundreds of tumuli, cave deposits, mounds, village sites, burial places and caches were destroyed simply for the relics they contained, few or no notes or observations being made.[2]

Today most collectors are better informed, and the cultural remains of the race that formerly occupied this continent, are carefully preserved, cataloged and labeled. Science has taken the lead and asks for facts. Today the pottery pipe and engraved gorget, and even the humble arrowhead are regarded as "archeological specimens." Definite scientific problems have arisen and challenge us to solve them. Every artifact left in the soil by the vanished red men may be of importance, if the associated facts are properly

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[1] Smithsonian Contributions to Knowledge, Vol. 1, embracing Ancient Monuments of the Mississippi Valley, by E. G. Squier and E. H. Davis, Washington, 1848. (Mss. accepted for publication in 1847.)

[2] Cf. Priest, Jeremiah, "Antiquities," Albany, 1834, page 110.

recorded. The position of a bannerstone in a grave may unlock some secret; the presence of pottery, even in the form of fragments, may shed important light upon a knotty problem in archeology. A conscientious collector observes and records everything for he knows that a careless collector is a destroying vandal who merely confuses himself and others, and ruins the field of inquiry for the better informed.

New York State for a full century has been systematically hunted for "relics," but only during the past twenty-five years has any scientific method been pursued on any considerable scale. Some early observations were made by H. R. Schoolcraft, L. H. Morgan, E. G. Squier, Franklin B. Hough, Frank H. Cushing and T. Apoleon Cheney, but some of these authorities did little more than point out the fertile field that existed within our borders. Observers at that time had not yet recorded the fact that the Iroquois did not use or make bannerstones; that stamped patterns characterized Algonkian pottery, or that grooved axes were found only on non-Iroquoian sites. It remained for later students such as W. M. Beauchamp, M. R. Harrington, Alanson Skinner, Frederick Houghton, and the present writer to differentiate types of occupation, though other observers working in other localities had perhaps cleared the way for an understanding of the New York cultural areas.

New York archeology owes much to the work of Professor Frederic W. Putnam, William H. Holmes, Charles C. Abbott, Cyrus Thomas, William C. Mills and Warren K. Moorehead, and in later days to Charles C. Willoughby, Christopher Wren and Col. George E. Laidlaw, all of whom, working in the areas surrounding New York, contributed information for a more adequate understanding of the New York field. It was Dr. William M. Beauchamp, however, who did most to draw attention to certain specific problems and his pioneer work has borne abundant fruit. His series of bulletins on New York archeological subjects, published by the State Museum, did much to stimulate study. Doctor Beauchamp was one of the first to point out evidences of Eskimoan influence in New York.

The State of New York presents a peculiarly inviting field for archeological investigation. It is not the most prolific, to be sure, but among the many areas where specific problems may be studied our field has at least an important place. In Ohio the mound culture may be studied with great advantage, in Tennessee the stone grave culture may best be examined, but in New York State the prehistory of the Iroquois may be investigated with greater advantage than in any other region we now know, not even excepting the province of Ontario.

The Iroquois were and are still the most recent aborigines to occupy this region; but they are late comers. Before them were other peoples. Our investigations show that long before the Iroquois came, the Algonkian tribes occupied at various times almost every portion of the State. There were also bands of the mound-building people, and at an earlier time, wandering tribes of people who made implements like the Eskimo.

Sources of Information

In making a systmatic examination of the field, information may be expected in certain definite areas and particular places. We must go where the evidences are in order to discover our data. In pursuing investigations and in making records, the following sources should always be kept in mind:

I. General Areas:
- 1. Inhabited areas:
  - a. Village sites.
  - b. Camp sites.
  - c. Shell heaps.
  - d. Hunting grounds.
- 2. Defensive works:
  - a. Fort rings.
  - b. Fort hills or points.
- 3. Places of Industry:
  - a. Workshop sites.
  - b. Quarries.
  - c. Garden beds.
  - d. Fishing places.
- 4. Places for disposing of the dead:
  - a. Cemeteries or burial grounds.
  - b. Ossuaries.
- 5. Places of conflict:
  - a. Battlefields.
- 6. Routes of traffic and travel:
  - a. Trails.

b. Stream beds.
c. Fording places.
7. Occasional or rare places:
a. River gravels.
b. Drift deposits.
c. Swamps.
d. River and lake bottoms.
e. River and lake shores.
f. Ceremonial districts and areas.
II. Particular places:
1. Sites of dwellings:
a. Lodge sites.
b. Cave and rock shelters.
2. Refuse deposits:
a. Fire pits.
b. Refuse pits.
c. Refuse heaps.
d. Shell heaps.
e. Signal light ash deposits.
3. Monuments:
a. Mounds.
b. Cairns.
c. Inscribed rocks.
d. Council rocks.
4. Burials:
a. Graves.
b. Ossuaries.
5. Places of Industry:
a. Kilns.
b. Individual work shops.
c. Fish weirs.
d. Clay pits.
6. Places for storing or hiding things:
a. Caches of implements finished, general.
b. Caches of raw material, general.
c. Individual caches.
7 Ceremonial places:
a. Springs.
b. Spots.
c. Rocks.

Evidences of Various Occupations

As suitable as the New York region is, and in former times was, for human occupancy, there is little evidence that there were any human beings here in as remote times as in western Europe. So far, no one has produced satisfactory proofs of man's presence during the glacial periods. We have never known of any implements from this State that may be classified as true paleoliths, as these things are known in Europe and elsewhere. Rock shelters and caves examined up to this time, while yielding some rude flints, do not indicate any remarkable antiquity.

We do not wish to imply that man could not have been here, or to lay stress upon a mere theory of his recent appearance. What we do wish to state is that up to this time competent observers have not seen in ancient gravel deposits or in glacial till any articles that look as if indubitably made or used by human hands. It may be that some time such evidences will be found and that man in this region will be shown to have lived here during and immediately after the last glacial period. We have no sympathy with a dogmatic theory that would seek to limit in an arbitrary way the time of man's first appearance upon the earth. Man certainly was on earth fifty thousand years ago; he may have an antiquity of five hundred thousand or more than a million years, if the evidence presented by the geologists is conclusive. Our contention is that man left no traces here yet discovered by which we may know of his occupation in pre-glacial times. Where upon this continent he was, if at all, we do not know. It is apparently true that certain Asiatic tribes in the periods following the last glaciation found their way over Bering strait and dividing and subdividing became the parent stems that later developed into the great linguistic families of the two continents. The first groups we should expect would push southward along the Pacific coast with comparative rapidity. The slower movement would be from west to eastern coast.

Indeed all the rest of North America north of Mexico had a population in aboriginal times scarcely equal to that of the Pacific coast states. The densest Indian population followed the west coast southward through the desert lands of New Mexico and Arizona into Central Mexico, Yucatan and Central America.

The pressure sent more into South America. Time, climate and food and, of equal if not primary importance, the original racial character and mental impulses caused these scattered units of the race to develop along similar physical lines. But while we think of the similarity of the branches of the red race we ought not expect them to be any more similar than the various branches of the Aryan or white race.

It is quite probable that many parts of North and South America had long been settled and that there were several millions of the red race before any large number of them crossed the great plains to begin a migration by slow stages to the Atlantic coast. The earliest comers seem to have had no habits that wrote a record into the soil. Perhaps they were nomadic and had a few settlements that endured longer than a year.

The oldest evidences of man's presence seem to be on some of the upper terraces. In western New York we have found several strange sites where the artifacts were crude and all osseous matter completely absent. The presence of carbonized material in the pits, however, proved that fire had been used. Along the headwaters of the Hudson similar old sites have been found. It would be mere guessing to say how old these places are or even that they are demonstrably the oldest.

As occupation becomes more evident, through the relics one finds, it is patent that the occupation is more recent. Thus, we may trace the historic Algonkian people by their artifacts to their prehistoric sites of occupation and these back to very rude sites that fade into others that may or may not be Algonkian.

On some of the sites that may be considered old the relics are greatly weathered. Certain sites near Oneida lake and others on the upper waters of the Hudson yield many crude flints and hatchet heads of stone that have plainly been weathered for centuries. But even in this case we can only say the relics appear to be among the oldest. The Algonkian people came to possess most of this area and in almost every portion of the State one may find Algonkian artifacts. For a considerable period wave after wave of Algonkian tribes came this way, one of the last being the Delaware. The Algonkian stock spread eastward from the Rocky mountains along the 55th parallel to the Atlantic coast, and occupied an irregular territory as far south as the 35th, even pushing wedges above and below these lines. Their east and west range, measured in longitude, spread from the 55th parallel to the 118th parallel, giving them a palmate shaped region many times greater in extent than that occupied by any other linguistic stock in North America.

The great original stocks of this period seem to have been the Athapascan, Shoshonean, Siouan, Algonkian, and the Muskhogean, Caddoan and Iroquoian. It may be that the last three stocks were originally one. There were fifty other linguistic stocks, according to Powell,[1] north of Mexico. Time and research may condense these to a less number.

After the Algonkian people had established themselves along the Atlantic coast and the country back of it, some of the mound-building tribes of the Ohio region pushed into New York, and thereafter followed several waves of the Iroquois.

The Algonkian tribes left traces, especially along the coast, but within the State their remains, while distinguishable, are feeble in comparison with the more vigorous and culturally rich Iroquois. The mound-building people did not occupy so much of this region, but where they did leave any evidence of themselves it is startlingly plain to the archeologist. The Iroquois who came last and who lived here for the shortest period of all, have left such abundant traces, such thick refuse deposits, and so many relics of their material culture that they appear to have not only lived on the land but to have actually used it. In viewing the remains of their occupation no anthropologist would make a mistaken estimate of their mental or moral energy.

Many untrained observers have sought to identify archeological specimens found in a given locality as the products of the tribe that last lived in the region. In view of the several occupations mentioned it will be seen how mistaken this notion may be in some cases. In certain places, such as the Genesee valley, there may be as many as four types of occupation. Thus it would be highly erroneous to say that the Seneca were responsible for all the relics found. Amateurs must avoid such erroneous conclusions, though even certain advanced students have made them through lack of means to fully identify cultures.

It would be presumption to say that we have named all the peoples that have lived within the borders of our present Empire State. It is possible that some other tribe contemporaneous with the early Algonkian peoples lived here, also, and that they were similar to the "red paint," people best represented in certain Maine

[1] Powell, J. W., 7th Report, Bureau of Ethnology, (1891), pp. 1–192.

sites. It is possible that several or many stocks now unknown and perhaps impossible to know left traces behind. Certainly there are many sites that are puzzling and that suggest an occupation by people the cultural stock of which we now have no means of determining.

The Algonkian Occupation of New York

Previous to the coming of the Iroquoian tribes to this region, it seems to have been largely in the control of the Algonkian tribes. It is quite possible, however, that portions were held by tribes not of this stock, but it is nevertheless true that an examination of the field shows traces of Algonkian occupation and influence from one end of the State to the other and from north to south. We may safely assert that when the Iroquois first entered this geographical area their chief opponents, if any, were some of the Algonkian bands, though it is probable, also, that there were outpost settlements of tribes of the mound builder culture.

The Algonkian occupation of New York stretches back into comparatively remote times. There must have been wave after wave of these peoples, coming in band after band to hunt over the territory or to make settlements. Very likely the inviting regions south of Lake Erie and the Ontario-St. Lawrence basin were as much occupied by Algonkian tribes as was New England at the time of the discovery.

The Algonkian occupation appears to consist of several periods, each of which so merges into the other that we cannot tell when or where one commences and the other leaves off. Even when we do distinguish differences in the cultural artifacts we find it is not always possible to say that the difference is due to the lapse of time and the change of pattern, or to the influence of another tribe that came to supplant an older tribe. Our best clues are found along the lakes and rivers where there have been fishing camps and settlements. On the St. Lawrence, for example, there are sites along the banks that are deep with the refuse of the centuries and where one may find early Algonkian material near the bottom and in the body of the layer, and Iroquoian potsherds on top. As a general thing, few individuals have had the time or patience to make a thorough study of the Algonkian occupation except along the sea coast. For solving the riddles of migrations and occupations, however, this difficult and perhaps unproductive work must be done.

The collector who desires to get relics only and the museum that only desires to fill its display cases are both neglecting an obligation to science. Research work alone will solve the problem of the Algonkian occupation.

Periods of occupation. The earliest type of occupational evidence, that we may assume to be Algonkian, yields crude implements, large, clumsy spears, some steatite pottery,[1] mullers and metates, occasionally a polished stone implement, net sinkers, large flakes of chert or stone notched at the top for choppers, and rude celts. Only in very few sites are any implements of bone found. The Lamoka Lake site, however, yielded more than 10,000 bone artifacts, being an exception.

Figure 1. TYPICAL GROOVED AXE, ALGONKIAN

A second or intermediate period of the Algonkian occupation is characterized by grooved axes, roller pestles, a greater abundance of pottery, the surface of which is scratched or stamped with fabric or cord marks, some steatite pottery, by pits filled with crumbling and almost completely disintegrated refuse and especially by the great abundance of drills, of notched arrowheads and spears of chert and other stone. Many of the finest ceremonial stones from New York belong to this intermediate period. The sites are generally along the waterways, on the banks or upon the high level fields near creeks, lakes, and rivers. To some extent early Algonkian sites are found in such places also, but most generally on the slopes and terraces far above the present river beds.

The third Algonkian occupation is more definite in character and covers almost the entire area of the State. It is characterized by numerous flints, by clay pottery, notched choppers, grooved axes, (see fig. 1), celts, adzes, hoes, some copper implements, gorgets,

[1] Some sites, as the first layers at Lamoka Lake, are non-ceramic.

birdstones,[1] bannerstones,[1] cord-marked and pattern-stamped clay pottery, (see pl. 91), mediocre clay pipes, (see fig. 2), roller pestles, numerous net sinkers, and a considerable amount of bone implements, as awls, harpoons, needles and beads. The sites are generally on lowlands near streams and lakes, none of importance being on hilltops. The later Algonkian peoples were agricultural as is proved by the numerous instances in which charred maize and beans have been found in refuse pits. The later Algonkian tribes were more sedentary than their predecessors and their settlements presumably larger. This seems to be indicated by the presence

Figure 2. **ALGONKIAN ELBOW PIPE**

of the deposits of refuse, by refuse pits and heaps and by large areas of ground filled with carbonized matter, fire-burned stone and calcined bone.[2]

Graves of this middle periods are found, the skeletons being doubled up on one side, (flexed). There are seldom any artifacts in the graves, the skeletons alone remaining to tell the story. A typical village site of this period was found on the outlet of Owasco lake, south of Auburn, and was excavated by Mr. E. H. Gohl and the writer. The Owasco lake site is similar in culture to that excavated at Lavanna on Cayuga Lake by the Rochester Municipal Museum in 1927.

The Algonkian peoples of the tide water and Long Island present a slightly different problem, but the culture is unmistakeable. The most abundant traces are found in the refuse layers and shell heaps

[1] In certain sites only. They are not found in the later sites.
[2] Levanna and Owasco are examples.

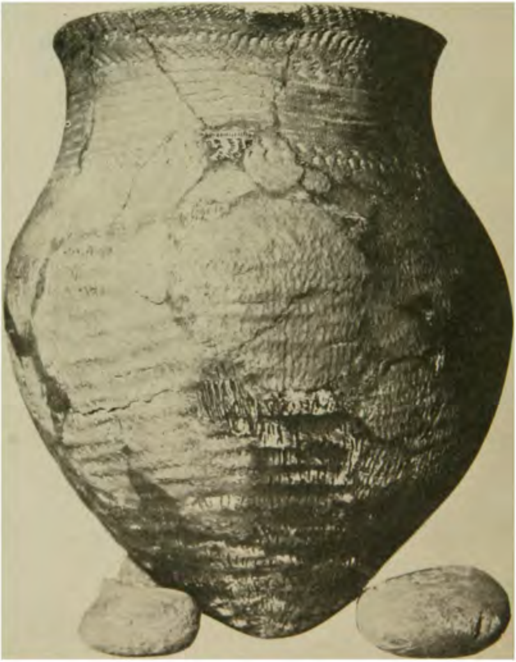
on Long Island, Staten Island, the Westchester coast and the northern end of Manhattan Island. The coastal Algonkin differed only from their inland kinsmen through the immediate influence of environment. For example, they frequently stamped their pottery with the edge of a scallop shell instead of a cord-wrapped paddle, and they used shellfish to a large extent for food.

Typical coastal Algonkian sites were found and excavated by Mr. M. Raymond Harrington, at Port Jefferson, Oyster Bay, Matinicock and Shinnecock, on Long Island; Throgg's Neck, Eastchester and Westchester on the Westchester coast; and by Mr. Alanson B. Skinner on Manhattan and Staten Islands.[1]

One is led to believe that the later Algonkin copied to a large extent the material culture of a more advanced division of the race that came from the south and the west, but which after a certain time was either absorbed or unable to maintain itself in the eastern section. That the eastern Algonkin received a great cultural impetus from the intruding strangers cannot be doubted. We have some realization of this when we note the thinning out of the polished slate objects in eastern New England, southern New York, Pennsylvania and the region north of the St. Lawrence basin, including the Erie-Ontario slopes, in Canada. On the contrary, these articles appear in the greatest abundance west of the Mohawk headwaters, westward into Ohio and down the Allegheny to the Ohio river and southward to Tennessee. The St. Lawrence basin all along the Great Lakes also yield the "problematical" slates, but there the cultural stimulus in other ways seems to be from the north.

Definite traces of what is recognizable as an Algonkian occupation occur from the Genesee valley throughout its length in New York, Wyoming and Monroe counties containing many camp sites and a considerable number of villages of this culture. Evidences are found eastward through the Finger Lakes district, southward along the valleys of the Chemung, Susquehanna and Chenango, through various portions of Chenango, Otsego and Oneida counties. In Jefferson county to the north along the St. Lawrence are also abundant traces. Southward along the Delaware river through the counties of Delaware, Ulster, Sullivan, Orange and Rockland the relics of occupation seem almost entirely Algonkian. The Hudson valley shows an Algonkian occupation as evidenced by the forms

[1] See Anthropological Papers, American Museum of Natural History, Vol. III., 1909.



ALGONKIAN POT

Typical Algonkian pottery vessel of the Third period. Note the impressed markings near the rim and the paddled surface of the body. Note that Algonkian pots of this period are ovate with the smaller end down. This specimen was restored from numerous fragments and was found crushed in a pit at Levanna, Cayuga County, N. Y. In height it is 12 inches of pottery and other artifacts. In some places Algonkian articles are found directly beneath Iroquoian deposits, as at the mouth of Honeoye creek and along the shores of the St. Lawrence river.

Methods of identification. In any endeavor to determine the cultural significance of any artifact there must be a certain and definite means of comparison. To fix the characteristics of a culture we must have before us the results of actual excavations and collections made in and on a site. In other words, we must reason from the known to the unknown. Once we know the characteristics of an Algonkian site we may look elsewhere and say with some degree of positiveness what is Algonkian. But to know in the beginning what is Algonkian we must find a site actually known to have been occupied by some Algonkian tribe and after examination we must find what the objects are, how they look, how they are decorated; and, what is equally important, we must determine what objects are associated. Not only must we study the ash pit and refuse heap, but the house site, the village site, the camp site and the fishing grounds.

Once we know the characteristics of an identified historical site, which may have within it European artifacts, we may look for older sites in which traces of the white man are absent. Then, when the general characteristics of the Algonkian culture are known we may say with some degree of assurance that a specimen is or is not Algonkian.

An examination of the numerous Algonkian sites in New York, and indeed elsewhere, demonstrates that the Algonkian culture was not uniform. This is not strange when we remember that the great Algonkian stock embraced many tribes and influenced this geographical area from comparatively remote times. It is natural to suppose that certain tribes varied in minor particulars from others and that in the process of time tribes may have changed some of their customs. There is an abundance of proof that this process of cultural change took place among tribes observed since the advent of the European. Changes took place, it is reasonable to suppose, in the eras before the white man came.

While it is true that our knowledge of the various occupations is incomplete, enough sites have been examined by competent observers to afford some basis for comparison and identification.[1]

[1] See, Archeological History of New York by A. C. Parker, N. Y. State Museum, 1922.

THE ESKIMO-LIKE CULTURE

In various localities throughout the State there are sites that seem to have been occupied at a very early period. The implements found are few and crude, with now and then the anomaly of some wonderfully fine specimen. The fire pits show little refuse and almost no bone, save fragments calcined by heat. In some of these sites fire-cracked stones are abundant. Graves are shallow and show no trace of osseous substance.

So far we have mentioned nothing especially characteristic, but when we discover highly polished semilunar knives of slate and rubbed slate double-edged knives and projectile points, (see pl. 92) we have something as a guide. Associated with these objects are found fragments of soapstone pottery. Chert arrowheads are broad, large, and have sloping shoulders. Some are almost lozenge-shaped and many have thick, wide necks as if used as lance or harpoon heads. Celts and polished stone scrapers are found on these sites as also are chert scrapers and perforators. On a few of these sites bone harpoons have been found in ashy deposits. Dr. O. C. Auringer found a beautiful walrus ivory dirk in an ash pit near Troy. Associated with it on the site were crude and much weathered flints. In some sites of this general cultural horizon will be found gouges, hemispheres of hematite, figurines, ornaments of unusual shapes, and many other unfamiliar artifacts.

It is evident that sites of this character are not Iroquoian, that they are not of the later clay pot-using Algonkian tribes, and that there is little distinctive in them resembling the mound-building people, except possibly for an occasional bird stone. Further study leads to the conclusion that sites of this character were once occupied by a people influenced by the Eskimo, if not actually by the Eskimo themselves. Our investigation points out that the influence came from the north, possibly the northeast.

It would be difficult to indicate any special center in this State from which this culture radiated. The areas showing traces of this Eskimoan influence are: (1) the St. Lawrence basin to Clayton; (2) the east and south shore of Lake Ontario from Clayton to Irondequoit Bay; (3) the Genesee valley; (4) the Finger Lakes region, including the entire drainage basin; (5) the Champlain valley; (6) the Hudson valley to Albany. Scattered relics are found in Western New York and in the valleys of the Susquehanna and Delaware with their tributaries. The culture thins out as it ranges

ESKIMOAN SLATE KNIVES

With the exception of 5 and 6 all these specimens were found along the Seneca River. Note the serrated necks of 1 and 4. 5 is from Glens Falls and 6 from Hudson. Scale: x [illegible] south, but it may be expected to appear in Vermont on the east and even in Massachusetts. Not much may be expected in either Pennsylvania or Ohio.

Many of these so-called Eskimoan sites appear to be of great antiquity, while others seem closely to approach the period of the middle Algonkian tribes. Indeed certain Algonkian sites that date to the opening of the colonial period seem in some ways to have been influenced by this northern culture. It is quite likely, therefore, that the period of influence [1] was a lengthy one. We may even be permitted to ask several questions concerning the people who left these evidences, these questions to constitute the problem set forth for solution by students of archeology. First, we may ask, were the people characterized by this culture true Eskimo? Second, if they were not of Eskimo stock, who were they? Were they Boethuck or Algonkin? Third, did not some undetermined people copy certain features of Eskimoan culture? Fourth, were these people exterminated, driven back to the north, or were they absorbed by later comers who perpetuated some of their arts?

It is possible that some time a painstaking student may discover and open up a site that will answer some if not all of these inquiries. Until then we may only point out the differences that we observe between these sites and others, and cautiously state that culturally they resemble those of the Eskimo. As for chronology these people seem to intrude the early second Algonkian occupation.

The Mound-Builder Occupation

There was a time when western New York was regarded as peculiarly the domain of a mysterious Preindian race known as the "mound builders."

Observers, astonished by the existence of earthworks and other prehistoric tumuli, have written elaborate descriptions and devoted considerable space to more or less melancholy speculation. The term "mould builder" became quite as romantically wonderful in the new world as that of Druid did in the old. Time and research have changed this view and it is now known that "mound builders" were Indians. The term is now used only to designate a particular culture.

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[1] Holmes thinks that " Eskimo influence may have, in cases, extended as far south as the Navajo country." An. Rep. Smithsonian Instn., 1919, p. 430.

Evidence of the mound culture, so-called, is based not only upon the presence of mounds of earth, but upon the presence of cultural artifacts that are similar and frequently identical with objects known as "mound builder" implements in the Ohio mound area.

Most of the mound remains in New York are found in the western part of the state, being most numerous in Chautauqua county and thinning out in the Finger Lakes area. True mounds are found about Chautauqua lake and the adjacent territory. Most have been destroyed, but one important mound still stands upon the nose of a terrace near Poland, not far from Falconer. Excavators have approached it from the top and hollowed it by a perpendicular tunnel, so that when we last viewed it it looked like a miniature volcano. It is mentioned by T. Apoleon Cheney, in one of the early State Museum reports. Further east near Napoli, upon a hill top is the ruins of a mound which had been walled up inside with a slab chamber. This was examined by Dr. Frederick Larkin,[1] who reported that it had never been adequately explored. The present writer visited this mound in 1905, guided by Dr. Larkin, then a man over 90 years of age. Local informants reported that strangers had torn it down, broken into the stoned-up chamber and discovered skeletons and a cache of flint spears.

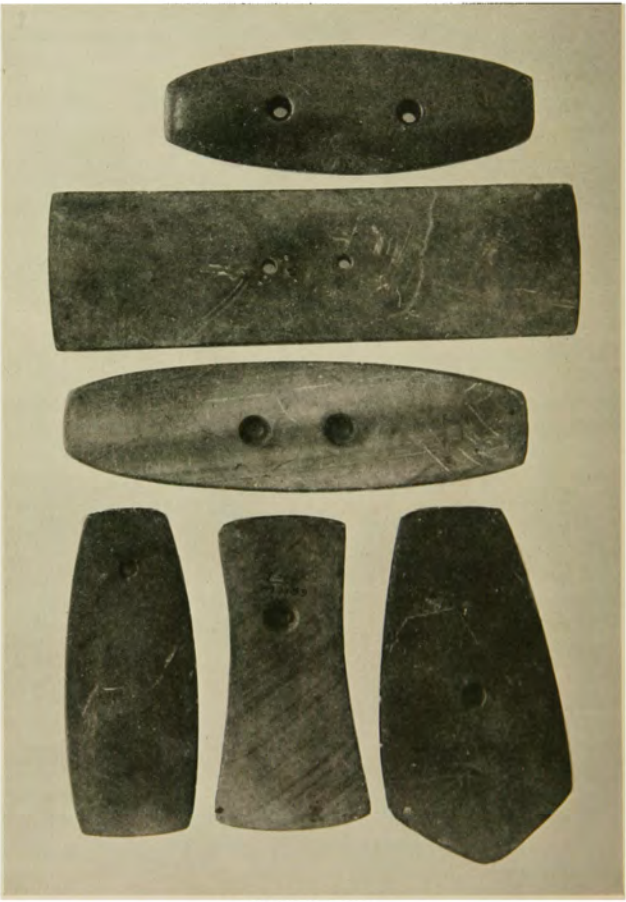
Along the Cattaraugus creek, in the confines of the Cattaraugus Indian reservation, at least ten mounds have been reported. Some were examined by Dr. A. L. Benedict for the Pan-American Exposition. The valley of the Allegany, also has revealed mounds, some of them, it was thought by T. King Jemison, an Indian excavator, resembling animal effigies.

Nearer the Genesee country, and indeed almost upon the banks of the river, is a series of three mounds upon the John C. White farm on Sqawkie hill. In one of these mounds stoned-up graves were found containing skeletons buried in an extended position. With one were pearl beads, a copper celt, a platform pipe, a double-cymbal ear ornament and some broad spears of fine workmanship.

An examination of the region about the mounds of New York indicate that the following artifacts are associated with the culture:

Platform pipes, celts, gorgets, (see pl. 93), birdstones, slate tubes, copper implements and ornaments, mica ornaments, shell beads and gorgets, heavy antler spears and harpoons, hematite articles, discoidal stones, some of them bi-concave, large spear heads and java-

[1] Ancient Man in America, p. 15. Miles Davis, printer, Randolph, 1880.



TYPICAL GORGETS

The first three are typical two-holed tablet gorgets found throughout the Genesee Country. The three arranged perpendicularly at the bottom of the plate are "one-holed" gorgets and are often called pendants. Gorgets of this type have the hole drilled at about one third the length and the holes are much larger than two or multiple-holed gorgets. Scale: x ⅝ lin points and notched arrowpoints of excellent workmanship. Much of the flinty material undoubtedly came from Flint Ridge, Ohio, and much of the banded slate is identical with that from the Ohio river. They made cord marked pottery.

An examination of the area contiguous to the mounds reveals that the people were agricultural, raising corn, beans, squashes, and tobacco; that they were village-dwelling and probably sedentary.

New York mounds are from 30 to 120 feet in diameter and seldom more than eight feet high, the vast majority being from three to five feet above the ground.

The mound-building people seem to have disappeared from New York at or before the time of the coming of the Iroquois into their recognized area of occupation. We cannot be entirely sure, however, that all were driven out or exterminated. A survey of the earliest Iroquoian sites, especially in western New York, leads us to believe that the earliest Iroquoian immigrants were measurably influenced by the mound-building culture. This is so appreciable that one is led to consider three propositions as within the bounds of possibility: first, that the Iroquois were originally a part of the mound-building peoples who had separated themselves from the main cultural body; second, that the Iroquois in entering this region absorbed large numbers of the mound Indians and adopted certain of their culture traits and rejected others; third, that the early Iroquois were merely influenced at their early entrance by the mound culture.

The earlier Iroquois sites frequently yield, especially in the graves, objects similar to those found in the mounds, but not gorgets, banner stones or related forms. To be explicit, the points of similarity between certain Iroquois forms and mound area forms, as between those of Ripley, N. Y.,[1] and Madisonville, Ohio, are certain pipes and certain pottery vessels. A prehistoric Iroquois site at Richmond Mills, N. Y., known as "The Old Indian Fort," has yielded metapodal scrapers, similar in every way to those found in Ohio mound sites. From these facts and from an examination of the entire field of the earlier Iroquoian occupation in New York and Ontario, we are led to believe that the Huron-Iroquois were the successors of the mound-building people in western New York and Ontario. Our belief is confirmed by the abundance of polished

[1] Excavations in an Erie Indian Village, Bulletin 117, N. Y. State Museum, 1907; see plate 30 and pl. 22, fig. 4.

slates in Ontario in close proximity to the later Huron-Neutral sites. This fact has confused some archeologists, and led to the statement that the polished slates are Huron or Neutral artifacts, but the graves of the two peoples tell different stories.

The Iroquois once established culturally, did not copy mound artifacts. Indeed, they seem to have deliberately avoided the use of the distinguishing badges of their vanquished foes. Just as the conquerors of the first mound people of Ohio beat up the mica ornaments and hammered into shapeless masses the copper tools and gorgets of their despised victims, so did the Iroquois taboo or avoid with deliberateness, the birdstone, the gorget and similar artifacts of polished slate.

Thus we may account for the difference between the pottery, decorative art, implements, and earthworks of the Iroquois and their predecessors. This difference likewise makes it possible for us to define the polished slate area and at the same time to fix the limits of the Iroquoian.

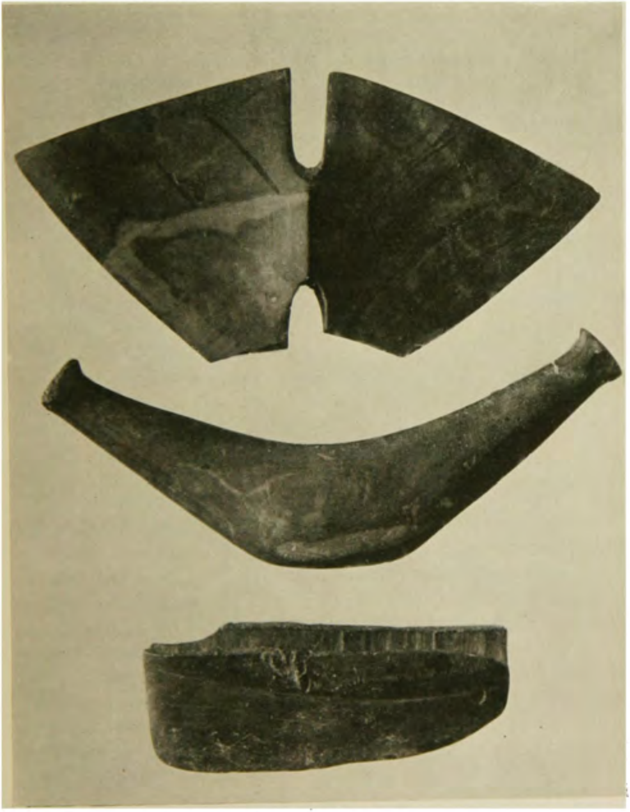
One final observation remains to be made about the mound builders as a people. We are induced to believe that the period during which they occupied this region was a longer one than generally estimated. It appears as characteristic of a certain cultural development and then sharply and totally disappears.

The Iroquois Occupation [1]

The origin of Iroquoian material culture is a subject of pertinent interest to every student of aboriginal American archeology. This particular racial stock, characterized by so many striking features, has long held the attention of historians and archeologists, but hitherto no one has attempted an analytical study of Iroquoian archeology or sought to correlate its salient facts. Much remains to be discovered, it is true, but we believe that we may now safely attempt to define the material culture of the Iroquois, so far as we may know it through archeology, and to make some intelligent inquiry into the origin of the culture as well as of the stock itself. By making this start, however faulty it may be, we hope to suggest lines of inquiry that may lead others to the discovery of facts that will point out a full solution.

Most writers have observed that there are a few places where Iroquoian artifacts are found unmixed with evidence of contact

[1] Cf. the author's article in The American Anthropologist, V. 18, No. 4, Oct.-Dec. 1916.



BANNER STONES

The upper and lower banner stones show breakage. The first is a fine example of a winged or butterfly stone, the lower tips of the wings being broken. The middle object is a crecentric or horned banner stone with knobbed ends. At the bottom is a palmate banner stone broken at the centrum and showing the drilling with the European. The few early sites, of precolonial occupation, therefore are most instructive to the investigator, but, as a matter of fact, the purely aboriginal material found in such sites differs but slightly from those of later date, except those of a very recent period. The archeology of the Ouendat or Huron is apparently quite similar to that of the confederate Iroquois.

In pursuing our inquiry it is soon discovered that there are definite centers in which material known to be, or termed, Iroquoian may be found. In scattered spots edging these centers are isolated Iroquoian specimens, as on Manhattan Island. But the fact remains that Iroquoian artifacts are found in numbers only within certain definite centralized localities, and that these objects are not seemingly more than 500 or 600 years old. Many sites show an age of less than 250 years. At most, let us say tentatively, that within the well-recognized areas, objects recognized as Iroquoian seem only to indicate a period of cultural fixedness of less than 700 years.

The centers of prehistoric Iroquoian occupation,[1] recognized as such by the objects known to archeologists as Iroquoian, are: (1) the St. Lawrence basin with Montreal as a center, (2) the region between Georgian Bay and Ontario with Lake Simcoe as a center, (3) the Niagara peninsula in Ontario following the Grand river, (4) the Genesee river-Finger Lakes region, (5) Chautauqua county, stretching across the Pennsylvania neck into Ohio, (6) the highlands east of Lake Ontario in Jefferson county, (7) Oneida, Madison and Onondaga counties, (8) the Susquehanna about Elmira, (9) the Mohawk valley and highlands to the north, and (10) Niagara, Erie, Chautauqua and Genesee counties. Circles of various circumference may be drawn from these centers, and intercept smaller centers. This plan of approximating the areas is only a scheme to fix the localities in our minds, no attempt being made to make them independent localities with definite boundaries. The contour of the land, streams, lakes, lines of travel and danger from enemies largely determined the early limitations.

We wish now to inquire which of these centers are the oldest and if there is any possible means of determining the causes that made Iroquoian material culture differ from the surrounding Algonkian. We wish to inquire, as others have done before us, whence the Iroquois stock came into these centers and what clue may be found showing a migration from earlier centers. We wish to inquire just

[1] But compare Skinner, Iroquois Notes, Mus. Amer. Indian, 1918.

how definitely valuable Iroquoian objects, as they are now recognized, are in determining a migration from other regions.

Perhaps, then, we ought first to inquire just how permanent any form of material culture is and whether there have been any revolutions, not to say modification, in the material culture of a stock. We ought to consider that there are Algonkian tribes, for example, that are Siouan in culture and Siouan tribes that are Algonkian, as the Blackfeet and Winnebago respectively.

This leads us to inquire whether beginning about 600 or 700 years ago, Iroquois art and artifacts might not have been different? Or, if there then were no Iroquois in this region, might not they have had differently decorated pottery, for example, when they came than that later developed and now known as Iroquoian? This is a question archeology may some day answer. Our present knowledge gives us only the Iroquois potsherd and does not tell us why it is as it is.

There are certain Iroquoian traditions that seem to have good foundation, relating that at a certain period all the Iroquois were one people, living together and speaking the same tongue. Indeed so positive were the Iroquois of this that they could point out a certain woman and say that she represented the lineal descendent of the first Iroquoian family.[1] Yet the confederate Iroquois knew that she did not belong in the five tribes. She was a Neuter woman. "When the bands divided," the tradition runs, "it was found that the family of Djigonsase (Fat Face or Wild Cat) fell to the Neuter Nation." She was called Ye-gowane, The Great Woman, and she was "the mother of the nations." In the Dekanawida-Hiawatha tradition, a woman with this title is represented as being constantly consulted by both Hiawatha and Dekanawida. The latter was a Wyandot (Ouendat) from the Bay of Quinte, at the head of Lake Ontario. This points to an early recognition of blood relationship and a recollection of the time when the Erie, Neuter, Huron, Seneca and Mohawk-Onondaga were of one common tribe, a fact that archeology and philology, of course, definitely prove.

In this original tribe any culture revolution would definitely influence the various subdivisions and be carried by each as it separated eventually from the parent body. Constant intercourse would serve to preserve the culture until it became fixed. Now, assuming for the sake of argument that there was an "original tribe" and

[1] Cf. Parker, Buffalo, Hist. Soc., Vol. XXIII., (1919), p. 43 ff.

that a revolution did take place in the decorative art of the Huron-Iroquois, whence did that tribe come and when did its arts change? Traditions, again, point to a migration from the "southwest." Ethnologists are familiar with the Delaware Walum Olum, but few are familiar with Iroquois migration myths for the reason that they are few and those brief and difficult to recognize as such.[1] So many of the Iroquois (confederated) myths point to the southwest country, however, that we must pause to consider just why they have been handed down. We must ask why the "tree of the long sword-like leaves" is mentioned so often in the Dekanawida epic, and why so learned an Iroquois as Dr. Peter Wilson called it a "palm tree." We must consider why so many Iroquois expeditions were directed against enemies down the Ohio and on the Mississippi. We must consider, too, a certain alleged grammatical resemblance between the Caddoan languages and the Iroquoian. Perhaps all these considerations will be termed fanciful and lacking serious value, but even if this is admitted they do have the certain virtue of stimulating inquiry.

The older theory that the Iroquois originated or had their early home along the St. Lawrence, about Montreal, is not entirely without serious flaws. It is now believed, from archeological evidence, that certain Iroquoian tribes never came from the St. Lawrence region; for example, the Seneca. The Seneca and Erie divisions seem to have been as closely allied in western New York as the Onondaga and Mohawk were in northern and eastern New York. The Mohawk (or Laurentian Iroquois) never agreed with the Senecan division and there indeed seems to have been a long period of separation that made these two dialects more unlike than all the others of the five. It would seem that the early band of Iroquois had divided at the Detroit or the Niagara rivers, one passing over and coursing the northern shores and the other continuing on the southern shores of Erie and Ontario; and that the northern branch became the Huron and Mohawk-Onondaga; that those who coursed south of these lakes became the Seneca-Erie, the Conestoga (Andaste) and the Susquehannock. It also appears that the Cherokee and Tuscarora separated earlier than the Seneca and Huron-Mohawk divisions and perhaps absorbed other non-Iroquoian bands, still further modifying their vocabularies.

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[1] We place little credence in the Cusick account as embraced in his "Sketches of the Ancient History of the Six Nations."

In the analysis that follows we shall briefly consider the material culture of the Iroquois. In the topical discussion we have repeated certain facts mentioned elsewhere, not for the sake of emphasis only but to obtain another view of the same facts, when differently correlated.

Outline of the Material Culture of the Iroquois

The following artifacts are associated with the Iroquoian culture in the Genesee Country and other portions of New York:

Arrowheads. Iroquoian arrowpoints are thin isoceles triangles about one inch in length and a half inch broad. They are thinner and more skilfully made than those of the Algonkian people, excepting perhaps the Third Period, or later inland Algonkian tribes. Only a few notched points are found on Iroquoian sites, and most of these in graves.

Polished stone instruments. The Iroquois had few stone tools that can be classified as polished implements. Of these the celt or ungrooved axe predominates. Included with these are chisels and scrapers. Polished stone pipes are described elsewhere.

Stone tools. Iroquoian stone tools include hammerstones, mullers, notched-sinkers, sharpeners and rubbing stones.

Pottery. The pottery of these people in its characteristic form is easily recognized. It is usually well tempered and smooth surfaced. In the Mohawk-Onondaga area it is usually smooth. The typical pot is globular with a constricted neck and overhanging collar. This is most frequently decorated with incised lines, often in triangular plats of lines, the direction of the lines being reversed in each adjacent plat. The earlier pottery is frequently cord marked or has pseudo-fabric marking, similar to the Algonkian. In the Seneca-Erie area of western New York the vessels are seldom as artistically formed as with the Mohawk. The later pottery in the Genesee Country area is often globular, with a slightly flaring rim which is notched or serrated.

Bone, antler and shell. Numerous implements of bone and antler are found on Iroquoian sites. The most common are awls. Fish hooks are rather rare and three, four and five toothed combs occasionally found. Shell articles become more common on historic sites.

Fishhooks were of the simple hook type without a barb and resemble in every way the fishhooks found in the Ohio village sites, as at Madisonville. Occasionally bone whistles are found made from the long leg bone of some bird or the wing bone of a wild turkey.

Earthworks. No adequate idea of the prehistoric Iroquois can be had without some description or mention of their earthworks. Scattered through the western and northern portion of the State of New York are more than 100 earth embankments, ditches and circular inclosures. Most of these were probably not erected in any sense as earthworks but simply as the bases for a stockaded wall. Tree trunks from 15 to 20 feet high were trimmed off and placed from 6 inches to a foot in a shallow ditch in the top of the wall and the earth was packed in about them. The tops were further secured by being tied together with bark topes and withes. There are good historic descriptions of the palisaded inclosures. The area within them ranges from one-eighth of an acre to more than 7 or 8 or even 16, and it is supposed that they contained fortified villages or were places of refuge against both human and beast enemies. They do not differ in any way from the stockaded inclosures of the province of Ontario, in the Huron-Iroquois area. In some instances they do not materially differ from the eatrh inclosures found throughout Ohio. It may be said, however, that none of them are so extensive in size as such works as Fort Ancient, nor are the embankments more than 3 or 4 feet high, except in rare instances.

There are three general forms of the stockaded inclosure, the first being the hilltop stronghold which was naturally fortified on all sides and the narrow neck that connected the out-jutting hill with the general terrace of which it formed a part shut off with a palisaded wall. Deep ravines on either side brought natural protection from the sudden onslaught of enemies and the places were rendered further secure by having the neck protected by a stockaded wall and perhaps an outer ditch. The ditch served two purposes. It afforded the material out of which the wall was erected and it made it more difficult for the enemy to climb the stockade or to set fire to its base. Typical hilltop strongholds are those at Ellington, Chautauqua county, the Reed fort near Richmond Mills, Ontario county, the fort near Portage in Wyoming county, and the prehistoric Mohawk site at Garoga.

A second form of protected inclosure is irregular in form and follows somewhat the natural line of the ground. It may or may not be upon a hilltop. Examples of this form are found on Indian hill near Ellington, the stockade near Livonia, Livingston county, known as the Tram site, and near Macomb, St. Lawrence county, on the farm of William Houghton, near Birch creek, and Fort Hill, Auburn.

A third form is in enclosure more or less circular in form with a low wall and shallow outer ditch. Examples of these are such inclosures, as are found at Oakfield, Genesee county;[1] at Elbridge, Onondaga county, where there is a circular inclosure covering about three acres of ground; or the circular fort on the Lawrence farm in the Clear creek valley, near Ellington.

Usually within these inclosures pits are found in which refuse had been deposited or corn stored. The soil shows more or less trace of occupation and occasionally graves are found in one portion. Besides the choice of the spot as a natural defense there were other considerations, such as proximity to good agricultural land which, for primitive people with inadequate tools, must be a light sandy loam; a plentiful supply of water, nearness to the proper kind of timber and a location near a trail or stream navigable for canoes. It is not easy to determine, however, why some localities were chosen, for they are overlooked by hills from which the enemy could assail the fortification, or are situated in swamp lands. There were probably many considerations that attracted the Indians to these spots that have been obliterated with the destruction of the forests.

The earlier sites of this character in the Iroquois district in New York were upon the hilly lands south of the Great Lakes. It does not appear that the Iroquois came down from their hilltop strongholds except in few remote localities until about the beginning of the historic period when they began to build their towns on the lowlands nearer the shores of Lakes Erie and Ontario. This observation is especially true in western and central New York, but does not fully apply to the Iroquoian area in Jefferson county. It is quite likely that the Iroquois did not drive out all their enemies or take full possession of this territory until a short period before the opening of the colonial epoch. An example of village sites or earthworks upon or near the lake shores is that found at Ripley,

[1] These inclose about 10 acres of land and were described by Squier, figure 8, in his plate.

Chautauqua county. Most villages, however, were from 2 to 20 miles back from the shores of Lakes Erie or Ontario.

Mortuary customs. Many human remains are found buried beneath the ground, indicating that the body was intact when interred. Traditions and historical evidence point out also the custom of placing the body wrapped in blankets or skins in the branches of large trees, and there are preserved in the Seneca tongue the various terms employed to describe the details of this type of burial. Burial houses were also erected in which the bodies of the dead were placed until decay had reduced them to bones. For the disposal of these bones research shows that they were gathered up and buried in bundles in separate graves. Sometimes several skeletons are found in bundles in a single grave, with or without accompanying relics, as pots, flints, pipes, etc.

The Iroquois, especially the Neuter nation, the Huron and perhaps the Erie, also had ossuaries in which from ten to fifty or one hundred remains were placed. Few relics are ever found in ossuaries of the earlier period. In the individual burial, where the body was placed intact in the grave, the position of the remains is almost invariably on one side with the knees drawn toward the face and the hands placed near the face, this fixed position being that assumed by a sleeping person, drawn up to keep warm.

In the earlier graves there are few material objects, but as the time ranged into the colonial period more durable relics are found, showing the gradual growth of prosperity, and a greater abundance of material property. The burial objects that have survived the elements, are clay pots, clay and stone pipes, flint objects, as knives, triangular points, celts, bone objects, shell objects, etc. These are usually found near the chest, hands, or head. Among the hundreds of Iroquois graves and skeletons found by the writer, not one has been found "sitting up," and among the thousands or more of all cultures discovered none was sitting up, nor did the bones "crumble upon eposure to the air." The Iroquois had no definite orientation for the grave, no special side; the only general rule being the flexed position reclining on one side.

The predecessors of the Iroquois had also this rule though the makers of the stone graves sometimes placed their dead lying straight and on the back.

Miscellaneous observations. The Iroquois did not use vessels of steatite, but their carved wooden bowls of the longer type were fashioned like them in the sense of having handles or lugs at each end.

Iroquois textiles have never received a careful study, for they are little known, but the people wove nets, bags, belts, and even shoes. Their corn-husk footwear differ from the sandals or moccasins found in the caves of Missouri only in the fact that they are complete moccasins. *Small fragments of cloth and woolen bags prove that they early understood weaving and basketry.

The Iroquois carved wood and indeed the confederate Iroquois law required that the national feast bowl should represent a beaver. The idea of making receptacles resembling animals with their backs or heads hollowed out was common. Their wooden spoons had bowls shaped like clam shells and at the top of the handle was carved a bird or animal strikingly like those they modeled on pipes.

The Iroquois were an agricultural people of village dwellers. Early Iroquois villages were on hills overlooking valleys and were stockaded. The early villages had earth rings about them and sometimes an outer ditch. Upon the ring or wall of earth the palisades were erected. Later villages were in the valleys besides lakes and streams and were not stockaded. The Iroquois towns of the sixteeth and seventeenth centuries were increasingly without such a wall. The Iroquois did not build mounds, of the character known throughout Ohio or Wisconsin, at least when they used the pottery and pipes we have described.

Iroquois houses were of bark and there were large communal dwellings. Many of them held from five to twelve families or more. They had either a rounded or pitched roof with openings at the top, as vents for each fire beneath. The Iroquois did not ordinarily employ the conical skin tepee.

The permanency of their village life is indicated in a measure by their vast fields of corn and other vegetables. Agriculture exercised an immense influence over their national life and it was pursued with method and on a large scale. There are accounts of expeditions sent out to procure new seeds and vegetable foods. Corn pits are often found in village sites.

Iroquois consanguinity was matriarchal. There were various clans, having animal symbols and names. The women nominated the civil sachems and could veto the acts of the tribal councel.

The Iroquois cosmogony relates that a pregnant woman fell from the heaven world. She fell upon the back of a great turtle and gave birth to a female child. This child grew quickly to maturity and gave birth to two sons, good minded and evil minded, or more properly Light one and Dark one. The Light or shiny one molded man after seeing his own reflection in the water. He found his father dwelling on the top of a mountain that rose from the sea "to the east," and begged certain gifts from him, which were given, tied up in bags. Reaching his homeland again, the Light one opened them and found animals and birds of all kinds, trees and plants. The mother of the two boys died in giving them birth, killed by Dark one or the Warty (Flinty), who insisted in emerging through her armpit. The grandmother nursed the boys and bade them watch their mother's grave. The food plants and tobacco sprang from her grave. The sun and moon in other versions were made from her face, eyes, and limbs.

Nearly all Iroquois legends relate to incidents of the southwest. Many expeditions are told about, that relate to the country down the Ohio river. Few stories of the north are related. The north was only the land of great terrors and savage giants.

Comparison of the Iroquoian Culture

As has been seen in the foregoing description outlining the material culture of the Iroquois, there are certain definite things which characterize their handiwork. The Algonkian tribes, in some instances, erected earthworks or stockaded inclosures, but apparently far less in extent than the Iroquois. In this respect, the Iroquois more greatly resemble the Indians of Ohio and the southern states. With the exception of the size and height of the walls, their earthen wall inclosures do not greatly depart from certain Ohio forms. The Iroquois, however, in no sense erected mounds of the character found in Ohio, neither does it appear that they were numerous enough to require, or to be able to erect, such extensive earthworks. A greater number of these inclosures are found in New York, west of the Finger Lakes district and on the hilly regions of Chautauqua, Cattaraugus, Erie, Wyoming, Genesee, Livingston, and Ontario counties. A few are found eastward, as in Jefferson county, but a great majority are in the localities we have mentioned.

The Iroquois were an agricultural people like those of the south, as of Virginia and Georgia or in the mound district in Ohio and the Ohio valley. Corn cobs and other vegetables are frequently found in ash pits and refuse heaps in Iroquois village sites and the use of tobacco may be deduced from the prevalence of numerous smoking pipes.

Unlike the Indians of Ohio, who built the mounds and fortifications, or the southern Indians, as those of Georgia and Alabama, or the Algonkins east and north of them, the Iroquois did not use implements or ornaments of copper or mica, nor did they use ornaments of polished slate as gorgets, stone tubes, bird stones, boat stones, and banner stones. They did not use the bell-pestle or cylindrical pestle nor as a rule did they ornament their pottery with fabric marks, notwithstanding the fact that they wove fabrics similar to the impressions found on baked pottery in the Algonkian area. They did not use the grooved axe, common among all the peoples about them, nor did they have the monitor pipe commonly found in Ohio, Kentucky, the southern states, and throughout New England. Only in rare instances did they use flints having barbs and stemmed necks. The absence of these forms of implements is significant and is the result of something more than mere accident. The Iroquois had every opportunity for knowing of such objects, and they were fully capable of making them had they so desired. It appears from these facts that the Iroquois deliberately chose not to use these things, and tabooed them from being employed in any way. Apparently there was a direct attempt to banish such articles beyond the pale of their culture. On the other hand, the Iroquois did use stone tomahawks or celts and apparently mounted them in the same manner as contiguous nations. They did use the ball-headed wooden war club such as is widely found throughout the continent and their shallow mortars and mullers did not greatly differ from those used by the Algonkins.

Their dwellings were houses of bark formed much like an arbor, some with round and some with pitched roofs. Under normal conditions these houses were communal dwellings and large in size. There were no permanent dwellings circular in form, and mud huts or hogans were not used. It is quite apparent that from the earliest times they were an agricultural people, and neither archeology nor the testimony of early explorers or travelers indicates any wide difference in their village life from that of the Indians of Virginia and the Carolinas, for example. They relied very largely upon vegetable foods for their sustenance and the cultivation of the ground was regulated by certain customs. It appears that the Iroquois were far more like these Indians of the middle south in their village life than the Indians of the north, the Micmac, or the Malecite.

Of considerable importance in the study of comparative archeology, and we believe in the study of the origin of the Iroquois, is testimony of implements of pottery and smoking pipes. Iroquois pottery is perhaps the most durable and striking material found on their village sites or in their graves, and in both decoration and form is distinctive from most forms of pottery used by Algonkins. Before discussing this subject further, it may be well to state there are two general forms of Iroquois pottery, that is to say, there are two archeologic districts which yield pottery, which may be compared. The first and westernmost is the Huron-Erie area and embraces the Iroquoian sites on the Niagara peninsula in Ontario and the adjacent land to the west of it and north of Lake Erie, including also the territory in New York along the southern border of Lake Erie to the hilly land south of it. The second area is the Mohawk-Onondaga, and takes in the region of the St. Lawrence basin, the east shore of Lake Ontario, the south shore of the Oswego river, southward along the Seneca river, southward through the Susquehanna valley and eastward through the Mohawk valley. In the first district the outline of the pot does not show the high collar projecting so far from the neck as is common in the second district. In many cases the collar is a very narrow band and ornamented by parallel lines or by simple oblique lines, or none at all. In another variety the lines are formed in chevron patterns, but in larger plats. (For comparisons see pl. 5.) In this form the collar does not project very much from the body of the pot, and the decoration is carried down well on to the neck. There are instances where the triangular patterns and short lines follow a line of oblique lines drawn around the body of the pot below the rise of the neck. Such patterns are found on the vessels from Ontario and figured by Doctor Boyle, and by myself from Ripley, Chautauqua county. In the second district the wide overhanging collar becomes almost a fixed characteristic. Here it reaches the highest form of its special development and archeologists usually describe one of these pots for their ideal Iroquoian form. The pots in the first-named district usually have the more squat body and bulging sides. A careful comparison between the pottery vessels found by the writer at Ripley, N. Y., and those pictured by David Boyle as having been found by the Laidlaw brothers, in the sites along Balsam lake, Ontario, Canada, will show that while a general outline and form of the body is similar to the pottery of the Mohawk-Onondaga area, there are differences enough to warrant placing each district in a place by itself.

Certain forms of the Iroquoian pottery, as in western New York, does not greatly differ from those discovered in the mounds of Ohio, especially certain pottery forms described by Professor Mills of Ohio State University. The forms to which we refer are those having a globular body and short neck and a wide flaring mouth, the entire surface of the body being decorated with the marks of a paddle wrapped with grass stems, or brushed while still plastic, with the same material. Large fragments of such pottery were found by the writer in the prehistoric site at Burning Springs where they were intermixed with sherds of more conventional Iroquoian types. Some of this pottery does not differ materially from certain forms of Algonkian pottery except in the matter of shape. None of the pointed bottoms is found in the Iroquoian district in New York. Many Iroquoian vessels are small, containing not more than two quarts, while others are larger and have a capacity of several gallons. Complete vessels of the larger type are very rare but many hundreds of sherds of large vessels are found throughout Jefferson, Ontario, Erie, Montgomery, and Chautauqua counties.

In the study of the design found on the typically Mohawk pottery it seems apparent that the parallel lines arranged in triangles represent porcupine quill work such as is found on the rims of bark baskets. There are certain other features of Iroquoian pottery that lead one to believe that potters in making their vessels had in mind bark baskets. The square-topped collar is not dissimilar in form to the square top of the bark basket, and the dots placed around the upper edge seem to imitate the binding of the wooden rim of the basket. Oftentimes dots around the center of the body, at the beginning of the neck, seem like the stitch marks seen on bark basketry. This idea was first advanced by Frank Cushing, who gives a figure of an Iroquois basket which he says was copied in clay by potters. We believe that the idea is correct, but the Iroquois of historic times did not use bark baskets or vessels of this character. All their baskets that we have seen have had flat bottoms and in outline were more or less oval at the top. Other pottery patterns, such as those found throughout the Seneca district and western New York, have a narrow rim, on the lower side of which

IROQUOIAN POTTERY OBJECTS

In the top row the face effigy is from the corner of a pot rim. All other specimens are complete or fragmentary pipes of the Genesee Country area is a series of notches or projecting teeth. Sometimes this rim is devoid of these projections and has oblique parallel lines drawn at distances to the edge of the rim. This form is similar to the ordinary bark basket simply bound with an ash splint and an elm bark tape. It is of value to note for comparative purposes that the quilled or chevron pattern is far more prevalent in the Mohawk-Onondaga district than it is in western New York, or in the Seneca-Erie region.

It is of great importance to note that Iroquois pottery never has a circular or scroll-like design such as is found upon the pots of the south and upon certain Ohio village sites. The absence of any curved decorations or scroll designs is significant and is one of the things which points out a deliberate attempt to avoid the distinctive art of certain other tribes.

All Iroquoian pottery seems to have been built by the coil process, that is to say, it was formed by coiling ropes of clay upon a base and then worked into the desired shape by continuing the coiling process. Very few pots were blackened by pitch smoke, although some pipes were treated with this process.

Smoking pipes. Smoking pipes of both stone and clay are numerous in the Huron-Iroquois area. There are several general forms, but all bear striking resemblance to one another.

Iroquois pipes seem much different from those found in any other archeological area, and it does not appear at first thought that they were derived from any other forms except perhaps the smaller tubular form with its end bent upward at an angle. There are certain features, however, of Iroquois pipes that remind one of pipes of contiguous tribes. It will be noted that the monitor pipe of the mound-builder region has a bowl which resembles an oval vase with a flaring rim. The bowl is set down into the platform, the whole pipe of course being monolithic. The Iroquois did not use the platform pipe, as we have previously remarked, but they did employ every form of the stone bowl used on platform pipes. The bowl, however, was built in all its lines much like the monitor type, but submerged into the platform stem. The same remark applies to certain forms of effigy pipes where the bowl has an animal head projecting from it. Certain forms of Iroquois clay pipes have similar bowls but with a stem of the same material projecting from it. The Iroquois did not have anything identical with the mound types with beautifully formed effigies of complete birds, toads, frogs, and small mammals, such as are featured by Squier and Davis.[1] There is just one important exception to this statement, and it is that relating to the cruder form of effigies found on platform stems. On early Iroquois sites effigies of this kind are found in the so-called lizard or panther pipes. The platform, however, has disappeared and the bowl and the effigy have a different orientation. The effigy seems to have clung to a narrow strip of the platform which appears in the shape of a small stem, and the stem hole is drilled in the back of the effigy, the bowl of the pipe being drilled down through the top of the shoulders into the body of the effigy. The drilling shows in most cases a large conical or beveled hole. Other effigy forms show no traces of the platform or rod, as in the case of the lizard pipes which perch upon their own tails, but are conventionalized forms of birds, generally an owl, having the body at the shoulders drilled for a bowl and the stem hole drilled in the lower part of the back. Oftentimes in the front of the pipe a conventionalized projection is made to resemble the feet. These bear a perforation from which, no doubt, were suspended ornaments. Other forms of mound pipes used by the Iroquois without any alteration are those from the Erie region resembling animal claws and those modeled along cubical lines with a short stem base for the insertion of a reed. Iroquois and mound pipes interpreted and compared in the light of these observations show in general concept a remarkable similarity. They are more alike than are the pipes from the southern states or the Atlantic seaboard.

The stone owl pipe and the lizard pipe, which have been described best by Colonel George E. Laidlaw of the Provincial Museum of Ontario, are found in the early Iroquois sites in New York and undoubtedly sites in the same period throughout the entire Iroquois area. The Province of Ontario has yielded many, numbers of them have been found in New York, still others have been found through Maryland, Virginia, and the Carolinas. Others have been found elsewhere, but only occasionally.

These effigy pipes of the Iroquois in some ways remind one of the Cherokee pipes which have the effigy standing on the front part of the stem. In the Iroquois pipe, however, the stem has been

[1] It must not be forgotten that Iroquois effigy pipes were mostly of modeled clay and the mound effigy pipes of carved stone. Compare the effigies of these pipes, one with the other, and it will be seen how startlingly similar they are, where the same life forms have been imitated.

abandoned and the effigy has either sprung upon or grasped the bowl, or made it a part of itself. It is not difficult to conceive that this type might have been derived either from the Cherokee or mound pipes. A single dream of an old woman of the early tribe widely recounted among the people as a necessary provision demanded by the spirits might cause a modification in any line of material culture. We have only to examine the history of the modern drum dance of Ojibway and middle plains tribe to discover how a dream can institute a custom that becomes widely known and followed.

Iroquois pottery pipes are among the most interesting forms of their ceramic art and some of the best modeling is found in them. They bear upon their bowls the effigies of birds and mammals, animal heads, human heads, and representations of earthen pots and other objects. They are far more complex and made with greater care than are the Algonkian pipes. Iroquois clay pipes in fact are the most carefully made and best modeled clay pipes made by the aborigines of North America, north of Mexico. There are certain features about them that give a hint of the customs and costumes of the people who made them; for example, they show that the skin robe with the animal head still upon it was worn as a blanket and headpiece; they give an idea of facial decoration; they represent masked figures with their hands to their lips blowing, as in the false face ceremony, or they reveal their totemic animals. Some of them have numerous human faces modeled upon the stem and bowl and both the form of the face and the concept is still carried out by some of the Iroquois today, especially the Cayuga, who carved these faces upon gnarled roots as charms against witches.

The most common type of pipe among the Mohawk-Onondaga group is that having a flaring trumpet mouth. The Seneca-Erie, on the other hand, including the Hurons of the north, commonly used pipes having a cylindrical bowl upon which was a long collar decorated by parallel rings.

Early types of both clay and stone pipes made by the Iroquois show a type of decoration made by rectangular slots arranged in series. These slots, it has been suggested, were inlaid with pieces of colored wood or shell. None so arranged, has yet been found, so far as we are able to state. This slotting is a characteristic feature in certain early pipes.

Certain forms of pipes show how widely prevalent certain concepts prevailed among the Huron-Iroquois. Briefly, there are the owl-faced pipe, the blowing pipe with the human face, the ring collar pipe, the square top pipe with the flaring collar, the trumpet bowled pipe and others. It appears that Iroquois pies are a unique part of their culture.

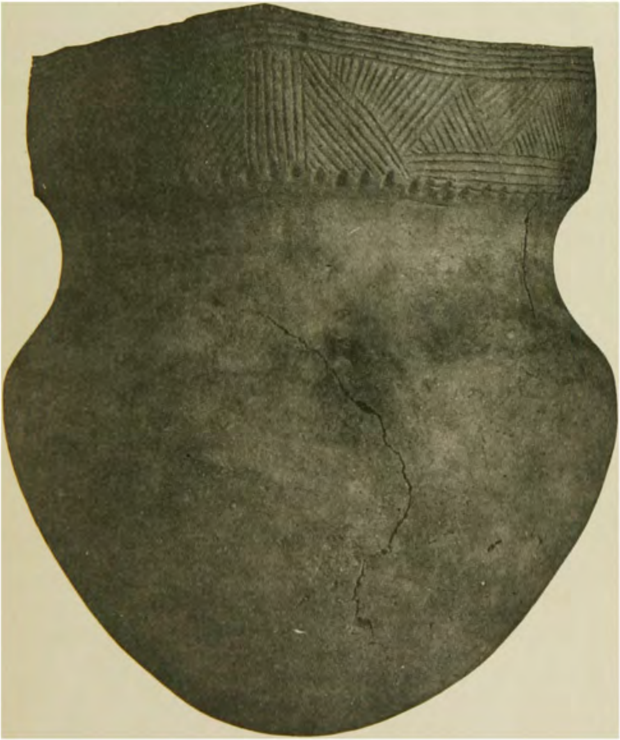
It is interesting to note the methods by which the stem holes of Iroquois pipes were produced. Probably the majority have had the hole punched through the stem while the clay was yet plastic but there are many specimens that show that the clay was rolled or modeled over a small reed, straw, or a wisp of twisted grass. When the clay was burned, the reed or grass burned out and left the stem hole.

The Iroquois as a means of interpreting culture. The Iroquois were in the Genesee Country when it was opened to white occupation. Not only did their ancient sites remain, but in 1650 more than 10,000, in all probability, occupied the region from the Finger Lakes to the Niagara Frontier and the Chautauqua region. These include the Erie, the Neutral, the Wenroe, the Seneca and Cayuga. Early missionaries, as the Jesuit fathers left valuable accounts of these people in their *Relations*. To these missionary records present day historians owe much.

Serious study of the culture of the Iroquois did not begin until the middle of the 19th Century, when Squier and Davis, Henry Schoolcraft, and finally Lewis Henry Morgan began to make investigations. Morgan's classic work, "The League of the Iroquois," did much to direct attention to the inestimable value of ethnological research. His studies of the Seneca people living in the Genesee Country provided new incentive to study the customs of native peoples, and, as a result, an entirely new interpretation of the history of mankind in general began to unfold.

Iroquois sites somewhat later began to receive attention and beginning about 1895 it was possible to differentiate somewhat the Algonkian and the Iroquoian occupations. Much more remains to be done for only the preface of the history of our aborigines has been read and recorded. Most of our conclusions are but tentative and as other sites are excavated, our array of facts may need modification.

From what has been gleaned from the present-day Iroquois of the past 75 years, many customs have been recorded that throw considerable light upon all Eastern American archeology. Beginning



IROQUOIS POT

This represents a typical Iroquoian pottery vessel of the eastern area. Note the incised decoration of the collar and the constricted neck of the vessel. This specimen was found on Manhattan Island. Height: 13 inches

Courtesy of the American Museum of Natural History with the Iroquois we may then reason back from the known to the unknown, basing our comparisons upon assured facts. This relieves the archeology of our particular area of much of the guess work that characterizes other regions. Even now, with 5,000 Iroquois still residing in the Empire State, there is ample opportunity for linguistic and ethnological study, and the possibility of finding many new facts of value to the study of pre-history.

The Problem of Chronology

The problem of chronology in America is a complicated one. There does not exist in the New World the same conditions and identical examples of cultural evolution which may be found in western Europe. It is, therefore, impossible to speak of American archeology in the same terms employed in the Old World. We have no paleolithic age, no Neanderthal skeletal remains, no Chellean implements. Only in Mexico and Yucatan do we find exact dates that may be compared with those of the Christian era.[1]

At best we may only differentiate our culture sequences and seek to determine which appear older. When we leave the historic or contact period dates are only approximations, yet, even so, they have the merit of assisting in visualizing the time element.

The earliest European explorers of the Columbian period, found the Atlantic seaboard from the mouth of the St. Lawrence to Georgia in the possession of a people whom we may definitely recognize as Algonkian. Explorers who penetrated the New York area and central Pennsylvania found tribes of the Iroquoian linguistic stock. Trading began and European cultural influences were soon felt by the aborigines. The immediate pre-contact period, therefore, for both Algonkian and Iroquoian peoples of New York closed about the year 1609.

Taking the Iroquois first, we may inquire into their history and traditions for earlier data. It will be found, many believe, that for nearly half a century previous to white contact they had undergone a transformation that eventually brought about the establishment of the Iroquois League in about the year 1570.

For information previous to this time it is necessary to take the evidence of archeology. Iroquoian sites that are purely aboriginal in culture may be traced fairly well from the recent to the precontact, and even further into prehistoric times. This is made

[1] Cf. Wissler, The American Indian, 270. New York, 1917.

possible by the fact that the Iroquois changed their village sites every ten or twelve years. In some instances, as the Ontario County the Richmond Mills site can be traced in a migration to at least two subsequent sites. Its earlier location may even be assigned.[1] This series of Seneca sites, therefore, may be traced back to what is probably the pre-confederated period.

The very definite culture of the Iroquois, the number of their locations and their traditions all being considered, it would appear that the date of their coming into this area may be fixed somewhere about the year 1300. This is about 300 years before the coming of the French, English, and Dutch explorers. It is also probable that for at least a full generation before this date advance groups of the stock were looking over the region and planning to dispossess the Algonkian peoples who claimed it.

The Algonkian sites into which the earliest Iroquoian settlements intrude, are similar in most details to known coastal Algonkian sites. Inasmuch as no European artifacts are found on these Genesee Country Algonkian sites, we may safely assign them to the pre-contact period. We may even postulate that with the advent of the Iroquois and the ascendency of these people, the Algonkian tribes were driven out.

The story of the earlier Algonkian peoples is now a matter of cultural changes. The later Algonkians were a people having a definite type of pottery. Their culture is easily recognizable by all students. Because of the definite characteristics of the immediate pre-Iroquoian Algonkian culture it has been tentatively called the "third Algonkian period." Coincidental with it and running back for at least three centuries (?) is the so-called mound culture, a culture also definite in character and easily distinguishable. Both peoples undoubtedly lived in adjacent areas and probably carried on a desultory warfare against each other. The third Algonkins without much doubt received a great cultural impetus from these intruders from Ohio. Tentatively we may date them from 1300 back to the first half of the tenth century, say, 950. This would give the mound culture two hundred fifty years in this region, an estimate which is not intended for any other area. Mound culture Indians were never numerous in New York and two hundred fifty

[1] Cf. Parker, A Prehistoric Iroquoian Site at Richmond Mills, Researches and Transactions of the N. Y. State Archeological Association, Vol. 1, No. 1.

years of occupation seems sufficient to account for the remains of these people in the Genesee Country.

Back of the later Algonkian peoples were earlier ancestors who seem to have occupied this region for a long period of time. It is so extensive and wide-spread that it may date back at least 4,000 years. This of course is an approximation, only, and hangs upon very slender threads of actual evidence. It is into this horizon that the Eskimo-like people intruded.

Still more remotely were other Algonkinoid peoples whose simple culture seems to have gradually evolved until it blends with that of the second period. We can only conjecture how far back they extend in time. Here it is necessary to correlate our approximations with the hypothetical date of the coming of man to America, conservatively set by some as at least 10,000 years ago.[1] A study of the distribution of the Algonkian stock sweeping eastward from the Rocky Mountains near the Canadian line would lead to the inference that it should not have taken more than three or four thousand years for bands of early people to have reached the Atlantic seaboard. It would be strange indeed to believe that the west coast had a population eight to ten thousand years ago and that the east coast should have remained totally unknown to man two or three thousand years thereafter. Certainly many implements and sites of early character appear in point of antiquity the equal of those in early neolithic Europe. For example the lower strata of the Lamoka Lake site, explored by the Rochester Municipal Museum yielded implements of bone and stone that compare in appearance with many specimens from the early neolithic sites of France. We cannot regard mere appearances, however, as solid evidence, without additional data to guide opinion. Geologists may be of considerable assistance in determining probable age and indeed some are now beginning to take much interest in American archeology.[2]

Some American anthropologists are now devoting much thought to the problem of chronology, notably Wissler, Hrdlicka, Kroeber, MacCurdy, Spinden, Cook, Sapir and Goddard. In his article in the *American Anthropologist* (Apr.-June, 1927), Goddard says, "If the less evident relationships which have been recently pointed out by Kroeber and Sapir are actual and some of them probably are,

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[1] Cf. Kroeber, Anthropology, 344.

[2] Cf. Figgins, Antiquity of Man in America, Natural History, Vol. XXVII, 229; Cook, New Geological Evidence, Ibid. 240. New York, 1927.

they go far back of this readjustment of peoples and may be due to separations of 100,000 or more years ago." Goddard is here speaking of linguistical differences between the various American groups.

Spinden seems more conservative and presents a diagram suggesting a chronology dating some 10,000 to 15,000 years B. C. He bases his graph largely upon culture traits, stressing agriculture.[1]

American archeologists for the most part have been conservative, and rightly so, perhaps, for theories should be constructed upon the logic of evidence. It is only recently that recognized experts have been bold enough to argue for an antiquity dating back more than two or three thousand years B. C.

The position assumed by the authorities cited above make it easier to project man in the Genesee Country further back than the Christian era. At least a thousand aboriginal localities are to be found in the Finger Lakes-Genesee Country, four or five hundred being listed in the four counties adjacent to Rochester. The fact that in the older sites there is little variation seems to argue for a greater antiquity than ordinarily assumed, for as early man progressed but slowly, and for several thousand years his artifacts and habits of living underwent little change. It is only as the historic age approaches and the great cultures of Mexico and the Mississippi Valley arose that the more primitive people of this region felt the influence of a new culture impetus. Only then are rapid changes in cultural traits seen. Mexico must have exerted an immense influence upon the people to the north. The rapidity of this change has possibly blinded some to the long era of culture monotony that preceded it.

Summary

The Genesee Country and the contiguous area to the east has been occupied from comparatively remote times by various peoples having cultural differences that make possible the classification of their remains and artifacts. Moreover, from the evidence produced by M. Raymond Harrington, Alanson B. Skinner, Frederick Houghton and the present writer, it is possible to state with some degree of certainty the various culture sequences.

The archaic Algonkian people appear to have been the first to enter this region, being succeeded by another wave of their stock

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[1] Cf. Kroeber, *Anthropology*, graph facing p. 342.

having a richer culture and bringing with them the art of pottery making. These people also appear to have practised agriculture including the raising of tobacco. A third wave of these people then spread their culture over the region and made their occupation easy to identify because of the excellence of their pottery ware and elbow smoking pipes.

When these Algonkian people were well established an influence from the Ohio region seems to have crept in, bringing with it the custom of rearing small mounds. Much of the raw material, as flint (chert) and banded slate seems to have been brought in from Ohio localities.

About three hundred years before the era of the French and Dutch along the St. Lawrence and Hudson the Iroquois seem to have established themselves in this region and to have driven out or absorbed the Algonkian tribes and possibly the wandering banks of mound culture people. The material culture of the Iroquoian people, including the Huron is distinctive and so markedly different from the Algonkian that it is easily recognized. The Iroquois people established a Confederacy about 1570 vestiges of which still remain to influence about 5,000 Iroquoian people now within the Empire State. At present the Iroquois are all but deculturated.

The field of Genesee Country archeology is eminently worthy of detailed study. It should be carried on only by qualified experts and recognized institutions. The numerous technical problems involved and the delicate cultural differences make the work of the amateur merely vandalism that leads to the destruction of important sources of knowledge.

So much has already been ruined by the well-meaning but destructive methods of untrained excavators that the field is limited and nearing exhaustion.

In point of time the occupation of this region may well date back three or four thousand years before Christ and even more, for it is not at all probable that eastern North America was unknown to man at so late a day as the rise of the Egyptian and Babylonian dynasties. Mexico had well established tribes and the beginning of a civilization several hundred years before the Christian era. This means an even earlier period of cultural evolution. It is generally believed [1] that the earliest groups of mankind came into America by way of the north Pacific coast at least as early as 10,000 years

[1] Cf. Handbook of American Indians, Vol. 1, Antiquity, p. 59. Hrdlicka.

ago. That it should have required five thousand years for man to cross the continent and find this region does not seem possible. The roving nature of early man coupled with his curiosity and daring would have soon led tribes across the continent. Indeed the range of the Algonkian people seems to indicate their sweep eastward at fairly remote times. How remote these first comers were in point of time we may only conjecture, and if dates are set, these only indicate the range of possibility. They constitute the trial stakes in a survey, that may be removed again and again until the real facts are established.

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The American Indian, (D. McMurtie), N. Y., 1917.

LIST OF PAPERS READ BEFORE THE ACADEMY

DATE	AUTHOR	TITLE
1919.		
Jan. 13,	George A. Chadwick	The rocks of the Genesee valley.
Jan. 27,	Charles C. Zoller	Natural color views of our western states.
Feb. 10,	Alvin H. Dewey	Some Indian villages and burial sites.
Feb. 24,	Dr. M. H. Given	The local milk situation.
Mar. 10,	Harold L. Alling	Beauties and uses of the petrographic microscope.
Mar. 17,	Joint meeting with the Rochester Section of the American Chemical Society	Utilization of kelp.
Mar. 24,	C. C. Laney	The Arnold Arboretum.
Apr. 14,	Florus R. Baxter	Preparation and uses of certain petroleum products.
Apr. 28,	Guy A. Bailey	Hunting birds with a camera.
May 12,	E. C. Avery	Our native wild flowers and their haunts.
May 26,	C. E. Kenneth Mees	The camera in war.
June 12,	H. L. Fairchild	Two theories of the earth's origin.
Sep. 22,	Several speakers	Summer experiences.
Oct. 13,	Louis A. Pechstein	Military psychology.
Oct. 27,	John M. Clarke	Lights and shades in New York geology.
Nov. 10,	H. L. Fairchild	Reptiles, ancient and modern.
Nov. 24,	Charles C. Zoller	Rochester parks in the colors of nature.
Dec. 8,	L. E. Jewell	Sunset phenomena and their causes.
1920.		
Jan. 12,	William D. Merrell	Modern theory of respiration.
Jan. 26,	John R. Murlin	Historical development of the U. S. army ration.
Feb. 9,	George H. Chadwick	Plankton, nekton and benthos.
Feb. 23,	Raymond N. Arnot	The economic supremacy of America.
Mar. 8,	James F. Barker	Application of the part-time school law.
Apr. 12,	Mrs. M. B. Steinhausen	Counseling the adolescent girl.
Apr. 22,	David White	Petroleum in the United States.
Apr. 26,	William A. Parks	Collecting big fossils along the Red Deer river in Alberta.
May 10,	Harry A. Carpenter	General science in the Rochester Junior High schools.
May 24,	William L. Bray	Development of bog vegetation with special reference to the Grasse river bog.
Sep. 27,	Several speakers	Summer experiences.
Oct. 11,	Edward W. Mulligan	Personal impressions of Japan.
Oct. 25,	Elliot P. Frost	Should psychology bake bread?

DATE	AUTHOR	TITLE
1920.		
Nov. 8,	JOSEPH ROBY	Causes of disease in relation to medical education.
Nov. 22,	HERBERT A. CLARK	How thermometers are made.
Dec. 13,	H. L. FAIRCHILD	The story of the Susquehanna valley.
1921.		
Jan. 10,	GEORGE H. CHADWICK	One hundred years of Rochester geology.
Jan. 24,	JOHN M. CLARKE	The end of evolution.
Feb. 14,	HENRY A. MATTILL	Vitamines, some unknown A, B, C's of nutrition.
Feb. 28,	T. L. HANKINSON	Bird photography.
Mar. 14,	LOUIS A. FUERTES	The coloration of birds and animals, the basis of camouflage.
Mar. 28,	W. CLARK TROW	The atypical child.
Apr. 11,	CHARLES C. ZOLLER	Natural color views of Florida.
Apr. 25,	JOHN H. COMSTOCK	Spiders.
May 9,	CHARLES C. ADAMS	The Roosevelt Wild-Life Forest Experiment Station.
May 23,	KARL W. WIEGAND	Botanizing in Newfoundland.
Oct. 10,	Several speakers	Summer experiences.
Oct. 24,	MRS. PORTER E. RITCHEY	Children's savings in the United States.
Nov. 14,	Several speakers	Geological symposium.
Nov. 28,	JOHN DUNBAR	Some flowering trees of the north temperate zone.
Dec. 12,	WILLIAM B. HOOT	Birds of New York, California and the Rockies.
1922.		
Jan. 9,	HAROLD L. ALLING	Behind the scenes when the rocks were made.
Jan. 22,	HAZEL M. STANTON	The measurement of musical talent.
Feb. 13,	JOHN R. MURLIN ALBERT D. KAISER MARY HOYT	Symposium on Nutrition.
Feb. 27,	FLOYD W. SCHMOE	Mount Rainier.
Mar. 13,	Several speakers	Symposium on birds.
Mar. 27,	CHARLES C. ADAMS	Caring for the Yellowstone wild life.
Apr. 10,	CHARLES C. ZOLLER	Rochester's suburbs in the colors of nature.
Apr. 24,	THOMAS L. WALKER	The zeolites of Nova Scotia.
May 22,	WILLIAM D. MERRELL	The present status of the evolutionary theory.
Oct. 9,	Several speakers	Summer experiences.
Oct. 23,	C. R. PETTIS	Our fast-dwindling forest resources.
Nov. 11,	CHARLES C. ZOLLER	Autumn in the colors of nature.
Nov. 27,	ALBERT R. SHADLE	Life history and habits of the lake lamprey.

DATE	AUTHOR	TITLE
1922.		
Dec. 14,	Henry N. Russell. In joint meeting with the Rochester section of the Optical Society of America.	The atomic theory and astrophysics.*
1923.		
Jan. 22,	Harold L. Alling	Geological observations in Iceland and Norway.
Feb. 14,	Fred E. Wright. Joint meeting with the Rochester sections of the American Chemical Society and the Optical Society of America.	The role of experiment in geology.
Feb. 26,	Conrad Vollertsen	The cultivation of hazelnuts.
Mar. 12,	Floyd W. Schmoe	The glaciers of Mount Rainier.
Mar. 26,	Leroy E. Snyder	Why we need a public library.
Apr. 9,	Herbert W. Job	Wild birds and their habits.
Apr. 23,	Guy A. Bailey	Honeybees.
May 14,	Byron Reed	Porto Rico and its native music.
Oct. 8,	Several speakers	Summer experiences.
Oct. 29,	Henry Warren Poor	Yellowstone National Park.
Nov. 12,	Charles C. Zoller	Rochester in natural colors.
Nov. 26,	Ellsworth Killip	Travels in the Colombian Andes.
Dec. 10,	H. L. Fairchild	The evolution of geology.
1924.		
Jan. 14,	Business meeting.	
Jan. 28,	John M. Clark	The enigmas of geology.
Feb. 11,	William B. Hoot	Experiences of a bird photographer.
Feb. 25,	Floyd W. Schmoe	Forests of the northwest.
Mar. 10,	William A. Parks	Evolution as illusrated by trilobites.
Mar. 24,	George L. English	Microscopic builders of marble edifices.
Apr. 14,	William D. Merrell	Carnivorous plants.
Apr. 28,	Dr. A. P. Sy	Some new things in nutrition.
May 5,	Edward T. Wherry	The cultivation of wild flowers.
May 12,	Floyd C. Fairbanks	The present status of astronomy.
May 26,	Karl Wiegand	Ithaca to Seattle by automobile.
Oct. 13,	Several speakers	Summer experiences.
Oct. 27,	H. L. Fairchild	Darien and its people.
Nov. 10,	Harold L. Alling	Geologic notes on England and Switzerland.
Nov. 24,	Roswell H. Ward	Development of the airplane and its application to commercial aviation.
Dec. 8,	Charles C. Zoller	Natural color photographs of the Adirondacks.

DATE	AUTHOR	TITLE
1925.		
Jan. 12,	A. C. Hawkins	The mountains of New England.
Jan. 26,	J. Douglas Hood	Insects in relation to man.
Feb. 9,	Henry H. Covell	A trip around the world.
	J. L. Roseboom	Esperanto.
Feb. 23,	Arthur C. Parker	The League of the Iroquois.
Mar. 9,	W. Parker Stowe	The biology of the cancer cell.
Mar. 23,	George L. English	From sunny Algiers to the snowless northland.
Apr. 13,	H. L. Fairchild	Physical features of Porto Rico.
Apr. 28,	Herbert E. Ives	Transmission of pictures by wireless.
	Joint meeting with the Rochester section of the Optical Society of America.	
Oct. 12,	Several speakers	Summer experiences.
Oct. 26,	Albert Kaiser	Hunting in the Cassiar mountains.
Nov. 9,	A. P. H. Trevelli	Holland.
Nov. 23,	Roswell H. Ward	Further development of the air service.
Dec. 14,	William D. Merrell	Evolution.
1926.		
Jan. 11,	Floyd W. Schmoe	Wilderness babies.
Jan. 26,	Arthur L. Day	The Santa Barbara earthquake.
	Joint meeting with the Rochester section Optical Society of America.	
Feb. 8,	Business meeting.	
Feb. 22,	Charles C. Zoller	Natural color photographs of the Adirondacks.
Apr. 12,	Mrs. Frank Pugsley	Wild flowers and associated wildings in the home garden.
Apr. 26,	F. W. C. Meyer	Switzerland in a day.
May 10,	Alfred C. Hawkins	Crystals.
Oct. 11,	Several speakers	Summer experiences.
Oct. 25,	George L. English	The great magnet in the west.
Nov. 8,	Herbert P. Lansdale	The Chinese puzzle.
Nov. 22,	Charles C. Zoller	Autumn in city and country.
Dec. 26,	F. W. C. Meyer	Highways and byways of northern Germany.
1927.		
Jan. 10,	Annual business meeting.	
Jan. 24,	Floyd W. Schmoe	Fire mountains of the northwest.
Feb. 28,	Arthur C. Parker	The relation of an academy of science to a museum.
Mar. 28,	John E. Hoffmeister	The Friendly Islands of the South Seas.

DATE	AUTHOR	TITLE
1927.		
Apr. 11,	Floyd C. Fairbanks	Some recent developments in astronomy.
Nov. 14,	Several speakers	Summer experiences.
1928.		
Jan. 23,	John E. Hoffmeister	Paleontology.
Feb. 27,	Guy A. Bailey	Birds and flowers of the Genesee valley.
Mar. 12,	J. Douglas Hood	An entomologist in our western deserts.
Apr. 9,	Richard Wendt	Animal psychology.
Oct. 22,	H. L. Fairchild George Y. Webster Warren A. Matthews	Symposium on the Mendon Ponds.
Nov. 26,	George L. English	South Africa, where science and ignorance meet.
Dec. 10,	Charles C. Zoller	Natural color photography.
1929.		
Jan. 28,		Demonstration of equipment in the Strong Memorial Hospital.
Feb. 25,	Sherman C. Bishop	Salamanders.
Mar. 25,	J. Douglas Hood	Evolution of social life among insects.
Apr. 22,	Charles C. Adams	California National Parks.

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Milroy N. Stewart* .... 36 Terrace Park
Miss Jennie Strowger .... 367 Alexander Street
Miss Olive J. Thomas .... University of Rochester
Robert C. Vance* .... 300 Hawley Street
Jesse L. Vanderpool .... U. S. Weather Bureau
George S. Van Schaick .... 15 Chadbourne Road
F. Hawley Ward .... 18 Grove Place
Harry C. Wardell* .... Municipal Museum
George Wendt* .... 18 Exchange Street
Mrs. George Wendt .... 18 Exchange Street
Mrs. L. L. West .... 89 Meigs Street
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INDEX, VOLUME VI

The papers in this volume, with one exception, carry tables of contents which serve the purpose of an index.