CHAPTER VIII.

Recession above the present position of the Falls — The Falls will be higher as they recede — Reason why — Professor Tyndall's prediction — Present and former accumulations of rock — Terrific power of the elements — Ice and ice bridges — Remarkable geognosy of the lake region.

THERE is probably little foundation for the apprehension which has been expressed that the recession of the chasm will ultimately reach Lake Erie and lower its level, or that the bed of the river will be worn into an inclined plane by gradual detrition, thus changing the perpendicular Fall into a tumultuous rapid. And for these reasons: The contour or arc of the Fall in its present location is much greater than it could have been at any point below. Consequently a much smaller body of water, less effective in force, is passed over any given portion of the precipice, the current being also divided by Goat and Luna islands. Also, the river bed increases in width above the Fall until it reaches Grand Island, which, being twelve miles in length by eight in width, divides the river into two broad channels, thus still further diminishing the weight and force of the falling water. The average width of the channel from Lewiston upward is one thousand feet. The present

curve formed by the Falls and islands is four thousand two hundred feet. Of course the water concentrated in mass and force below the present Falls must have proved vastly more effective in disintegrating and breaking down the shale and limestone than it possibly can be at any point above. After receding half a mile further the curve will be more than a mile in extent, and hold this length for two additional miles, provided the water shall cover the bed-rock from shore to shore.

In reference to this recession, Professor Tyndall, in the closing paragraph of a lecture on Niagara, delivered before the Royal Institute, after his return to England, says: "In conclusion, we may say a word regarding the proximate future of Niagara. At the rate of excavation assigned to it by Sir Charles Lyell, namely, a foot a year, five thousand years will carry the Horseshoe Fall far higher than Goat Island. As the gorge recedes * * * it will totally drain the American branch of the river, the channel of which will in due time become cultivatable land. * * * To those who visit Niagara five millenniums hence, I leave the verification of this prediction." In his "Travels in the United States," in 1841–2, vol. 1, page 27, Sir Charles Lyell says: "Mr. Bakewell calculated that, in the forty years preceding 1830, the Niagara had been going back at the rate of about a yard annually, but I conceive that one foot per year would be a more probable conjecture."

Thus it appears that the rate suggested was the result of a conjecture founded on a guess. From certain oral and written statements which we have been able to collect, we have made an estimate of the time which was required to excavate the present chasm-channel from Lewiston upward. During the last hundred and seventy-five years certain masses of rock have been known to fall from the water-covered surface of the cataract, and a statement as to the surface-measure of each mass was made. In using these data it is supposed that each break extended to the bottom of the precipice, although the whole mass did not fall at once. Of course, the substructure must have worn out before the superstructure could have gone down. Father Hennepin says that the projection of the rock on the American side was so great that "four coaches" could "drive abreast" beneath it. Seven years later, Baron La Hontan, referring to the Canadian side, says "three men" could "cross in abreast." We cannot assign less than twenty-four feet to the four coaches moving abreast. The projection on the Canadian side has diminished but little, whereas the overhang on the American side has almost entirely fallen, as is abundantly shown by the huge pile of large bowlders now lying at the foot of the precipice. Authentic accounts of similar abrasions are the following: In 1818, a mass one hundred and sixty feet long by sixty feet wide; and later in the same year a huge mass, the top surface of which was estimated at half an acre. If this estimate was correct, it would show an abrasion equivalent to nearly one foot of the whole surface of the Canadian Fall. In 1829 two other masses, equal to the first that fell in 1818, went down. In 1850 there fell a smaller mass, about fifty feet long and ten feet wide. In 1852, a triangular mass fell, which

was about six hundred feet long, extending south from Goat Island beyond the Terrapin Tower, and having an average width of twenty feet. Here we have approximate data on which to base our calculations. In addition to these, it is supposed that there have been unobserved abrasions by piecemeal that equaled all the others. Combining these minor masses into one grand mass and omitting fractions, the result is a bowlder containing something more than twelve million cubic feet of rock. If this were spread over a surface one thousand feet wide and one hundred and sixty feet deep—about the average width and depth of the Falls below the ferry—it would make a block about seventy-eight feet thick. This, for one hundred and seventy-five years, is a little over five inches a year. At this rate, to cut back six miles—the present length of the chasm—would require nearly sixty thousand years, or ten thousand years for a single mile, a mere shadow of time compared with the age of the coralline limestone over which the water flows. So, if this estimate is reasonably correct, two millenniums will be exhausted before Professor Tyndall's prophecy can be fulfilled.

As to the "entire drainage of the American branch" of the river, we must be incredulous when we consider the fact that the bottom of that branch, two and a half miles above the Falls, is thirty-two feet higher than the upper surface of the water where it goes over the cliff, and that there is a continuous channel the whole distance varying from twelve to twenty feet in depth; and the further fact that, in the great syncope of the water which occurred in

1848, the topography, so to speak, of the river bottom was clearly revealed. It showed that the water was so divided, half a mile above the rapids, as to form a huge Y, through both branches of which it flowed over the precipice below, thus showing that nothing but an entire stoppage of the water can leave the American channel dry. But even if this part of Professor Tyndall's prediction should be verified, it is to be feared that his "vision" of "cultivatable land" in the case supposed will prove to be visionary. "To complete my knowledge," says Professor Tyndall, "it was necessary to see the Fall from the river below it, and long negotiations were necessary to secure the means of doing so. The only boat fit for the undertaking had been laid up for the winter, but this difficulty * * * was overcome." Two oarsmen were obtained. The elder assumed command, and "hugged" the cross-freshets instead of striking out into the smoother water. I asked him why he did so; he replied that they were directed outward and not downward." If Professor Tyndall had been at Niagara during the summer season, he would have had the opportunity, daily, of seeing the Fall "from below," and of going up or down the river on any day in a boat. All the boats (four) at the ferry are "fit for the undertaking," and all of them are, very properly, "laid up in the winter," since they would be crushed by the ice if left in the water. The oarsmen do not consider themselves very shrewd because they have discovered that it is easier to row across a current than to row against it. The party had an exciting and, according to Professor Tyndall's

Opposite page 54. Niagara Falls, from Below.

account, a perilous trip. It is an exciting trip to a stranger, but the writer has made it so frequently that it has ceased to be a novelty.

"We reached," he says, "the Cave [of the Winds] and entered it, first by a wooden way carried over the bowlders, and then along a narrow ledge to the point eaten deepest into the shale." He also speaks of the "blinding hurricane of spray hurled against" him. This last circumstance, probably, prevented him from noticing the fact that no shale is visible in the Cave of the Winds. Its wall from the top downward, some distance beneath the place where he stood, is formed entirely of the Niagara limestone. But it is checkered by many seams, and is easily abraded by the elements.

Long-continued observation of the locality enables the writer to offer still other reasons why the Fall will never dwindle down to a rapid. As has already been noticed, the course of the river above the present Falls is a little south of west, so that it flows across the trend of the bed-rock. Hence, as the Falls recede there can be no diminution in their altitude resulting from the dip of this rock. On the contrary, there is a rise of fifty feet to the head of the present rapids, and a further rise of twenty feet to the level of Lake Erie. During 1871–2, the bed of the river from Buffalo to Cayuga Creek was thoroughly examined for the purpose of locating piers for railway bridges over the stream. The greatest depth at which they found the rock—just below Black Rock dam—was forty-five feet. Generally the rock was found to be only twenty to twenty-five feet below the surface of the water.

About five miles above the present Falls there is, in the bottom of the river, a shelf of rock stretching, in nearly a straight line, across the channel to Grand Island, and having, apparently, a perpendicular face about sixteen inches deep. Its presence is indicated by a short but decided curve in the surface of the water above it, the water itself varying in depth from eleven to sixteen feet. The shelf above referred to extends under Grand Island and across the Canadian channel of the river, under which, however, its face is no longer perpendicular. If the Falls were at this point, they would be fifty-five feet higher than they are now, supposing the bed-rock to be firm. Now, by excavations made during the year 1870 for the new railway from the Suspension Bridge to Buffalo, the surface rock was found to be compact and hard, much of it unusually so. As a general rule it is well known that the greater the depth at which any given kind of rock lies below the surface, and the greater the depth to which it is penetrated, the more compact and hard it will be found to be. The rock which was found to be so hard, in excavating for the railway, lies within six feet of the surface. The deepest water in the Niagara River, between the Falls and Buffalo, is twenty-five feet. At this point, then, it would seem that the shale of the Niagara group must be at such a depth that the top of it is below the surface of the water at the bottom of the present fall. Hence, being protected from the disintegrating action of the atmosphere, and the incessant chiseling of the dashing spray, it would make a firm foundation for the hard limestone which would form the perpendicular ledge over which the water would fall. Supposing the bottom of the channel below this fall to have the same declivity as that for a mile below the present fall, the then cataract would be, as has been before stated, fifty-five feet higher than the present one. If we should allow fifty feet for a soft-surface limestone, full of cleavages and seams which might be easily broken down, still the new fall would be five feet higher than the old one. But, so far as can now be discovered, there is no geological necessity, so to speak, for making any such allowance. In the new cataract the American Fall would still be the higher, and its line across the channel nearly straight. The Canadian Fall would undoubtedly present a curve, but more gradual and uniform than the present horseshoe.

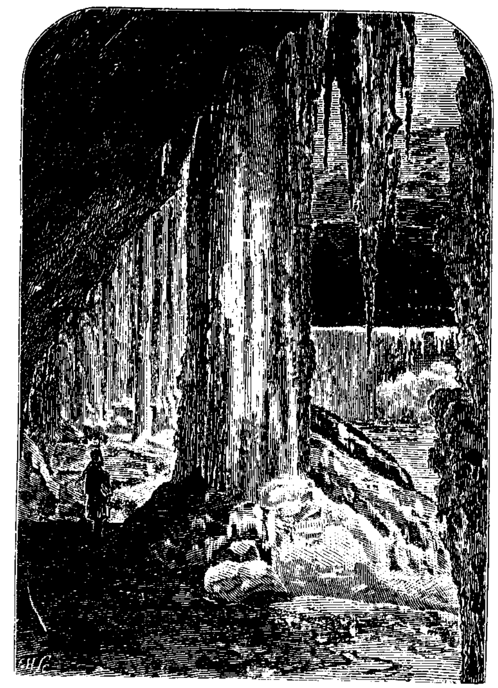
But there might possibly occur one new feature in the chasm-channel of the river as the result of future recession. That would be the presence in that channel of rocky islands, similar to that which has already formed just below the American Fall. The points at which these islands would be likely to form are those where the indurated rock of either the Medina or the Niagara group lies near the surface of the water. This probably was the case at the narrow bend below the Whirlpool, before noticed, and from thence up to the outlet of the pool. After considering what must have occurred in the last case, we may form some opinion concerning the probabilities in reference to the first.

We can hardly resist the conclusion that masses of fallen rock must have accumulated below the Whirlpool as we now see them under the American Fall. But if so, where are they? The answer to this question brings us to the consideration of the most remarkable phenomenon connected with this wonderful river. To the beholder it is matter of astonishment what can have become of the great mass of earth, rock, gravel, and bowlders, large and small, which once filled the immense chasm that lies below him. He learns that the water for a mile below the Falls is two hundred feet deep, and flows over a mass of fallen rock and stone of great depth lying below it; he sees a chasm of nearly double these dimensions, more than half of which was once filled with solid rock; he beholds the large quantities which have already fallen, which are still defiant, still breasting the ceaseless hammering of the descending flood. For centuries past this process has been going on, until a chasm seven miles long, a thousand feet wide, and, including the secondary banks, more than four hundred feet deep, has been excavated, and the material which filled it entirely removed. How? By what? Frost was the agent, ice was his delver, water his carrier, and the basin of Lake Ontario his dumping-ground. Although there is little likelihood that islands similar to Goat Island have existed in the channel from Lewiston upward, still it is probable that, when the Fall receded from the rocky cape below the Whirlpool up to the pool, it left masses of rock, large and small, lying on the rocky floor and projecting above the surface of the water. As there were no islands above, there were no broken, tumultuous rapids. As has been before remarked, the water poured over in one broad, deep, resistless flood. When

frozen by the intense cold of winter, the great cakes of ice would descend with crushing force on these rocks. The smaller ones would be broken, pulverized, and swept downstream, the channel for the water would be enlarged gradually, and the larger masses thus partially undermined. Then the spray and dashing water would freeze and the ice accumulate upon them until they were toppled over. Then the falling ice would recommence its chipping labors, and with every piece of ice knocked off, a portion of the rock would go with it. Finally, as the cold continued, the master force, the mightiest of mechanical powers, would be brought into action. The vast quantities of ice pouring over the precipice would freeze together, agglomerate, and form an ice-bridge. The roof being formed, the succeeding cakes of ice would be drawn under, and, raising it, be frozen to it. This process goes on. Every piece of rock above and below the surface is embraced in a relentless icy grip. Millions of tons are frozen fast together. The water and ice continue to plunge over the precipice. The principle of the hydrostatic press is made effective. Then commences a crushing and grinding process which is perfectly terrific. Under the resistless pressure brought to bear upon it, the huge mass moves half an inch in one direction, and an hundred cubic feet of rock are crushed to powder. There is a pause. Then again the immense structure moves half an inch another way, and once more the crumbling atoms attest its awful power. This goes on for weeks continuously. Finally the temperature changes. The sunlight becomes potent; the ice ceases to form; the warm rays loosen the grip of the ice-bridge along the borders of the chasm below. The water becomes more abundant; the bridge rises, bringing in its icy grasp whatever it had attached itself to beneath; it breaks up into masses of different dimensions: each mass starts downward with the growing current, breaking down or filing off everything with which it comes in contact. Fearful sounds come up from the hidden depths, from the mills which are slowly pulverizing the massive rock. The smaller bits and finer particles, after filling the interstices between the larger rocks in the bottom of the chasm, are borne lakeward. The heavier portions make a part of the journey this year; they will make another part next year, and another the next, being constantly disintegrated and pulverized.

This work has been going on for many centuries. The result is seen in the vast bar of unknown depth which is spread over the bottom of Lake Ontario around the mouth of the river. On the inner side of the bar the water is from sixty to eighty feet deep, on the bar it is twenty-five feet deep, and outside of it in the lake it reaches a depth of six hundred feet.

And finally, to the force we have been considering, more than to any other, it is probable that all the coming generations of men will be indebted for a grand and perpendicular Fall somewhere between its present location and Lake St. Clair; for it must be remembered that the bottom of Lake Erie is only fourteen feet lower than the crest of the present Fall, and the bottom of Lake St. Clair is sixty-two feet higher. It may also be considered that the corniferous limestone of the Onondaga group—which



Great Icicles under the American Fall.

Opposite page 60.

succeeds the Niagara group as we approach Lake Erie — is more competent to maintain a perpendicular face than is the limestone of the latter group.

We may here appropriately notice a remarkable feature in the geognosy of the earth's surface from Lake Huron to the Gulf of St. Lawrence. We have before stated that the elevation of that lake above tide-water is five hundred and seventy-eight feet. But its depth, according to Dr. Houghton, is one thousand feet. If this statement is correct, the bottom of it is four hundred and twenty-two feet below the sea-level. The elevation of Lake St. Clair is five hundred and seventy feet. But its depth is only twenty feet, leaving its bottom five hundred and fifty feet above the sea-level. The elevation of Lake Erie is five hundred and sixty-eight feet. But it is only eighty-four feet deep, making it four hundred and eighty-four feet above the sea-level. From Lake Erie to Lake Ontario there is a descent of three hundred and thirty-six feet. But the latter lake is six hundred feet deep, and its elevation two hundred and thirty-two feet. Hence the bottom of it is three hundred and sixty-eight feet below the sea-level. From the outlet of Lake Ontario the St. Lawrence River flows eight hundred and twenty miles to tide-water, falling two hundred and thirty-two feet in this distance. The water from the springs at the bottom of Lake Huron is compelled to climb a mountain nine hundred and eighty feet high before it can start on this long oceanward journey.