comprehensive were the agencies set to work: glaciers that reached across from ocean to ocean; rivers deriving magnitude and energy from the loftiest of mountains, the greatest of ice-sheets and the most abundant of rains; and a genial climate that reached almost to polar latitudes, and produced luxuriant growth in all life, animal as well as vegetable. Thus were evolved, as never before, the sublimity of the mountain peaks, and the richness and varied beauty of the valleys and wide-reaching plains, and the many other surface details that were essential to the pastoral and agricultural pursuits with which man was to commence his own development.

GENERAL OBSERVATIONS ON GEOLOGICAL HISTORY.

LENGTH OF GEOLOGICAL TIME.

Time-ratios. — In the preceding edition of this work estimates are given of the *relative lengths* of the ages and periods, or their time-ratios, based on the *maximum thicknesses* of the rock formations of the several periods, allowing a ratio of 1 to 5 between the rate for limestone and that for ordinary fragmental rocks. These thicknesses have since been increased much for some parts of the geological column; but the increase is not far from proportional to the former numbers. The evidence at present obtained appears to favor the conclusion that the relative duration of the Cambrian and Silurian, the Devonian and the Carboniferous eras, corresponds to the ratio $4\frac{1}{2} : 1 : 1$, or perhaps $4 : 1 : 1$, the ratio hitherto adopted; and for the Paleozoic, Mesozoic, and Cenozoic, $12 : 3 : 1$. The thickness of upturned rocks is so difficult to obtain with accuracy, and is so certainly exaggerated greatly when the absence of faults and flexures is not ascertained before drawing conclusions, especially in connection with the older tilted formations, that much careful geological work is yet to be done before reliable ratios can be deduced.

Length of time since the Glacial period. — The facts with regard to the present rate of recession of Niagara Falls have been used for calculating the length of time since the Glacial period. The argument has been presented thus. Niagara has made its present gorge by a slow process of excavation, and is still prolonging it toward Lake Erie. Near the fall, the gorge is 200 to 250 feet deep, and 160 feet at the fall, — the lower 80 feet shale, the upper 80 limestone. The waters wear out the shale, and thus undermine the limestone. The rocks dip 15 feet in a mile up stream, so that the limestone at the fall becomes thicker, as retrocession goes on. The distance from Niagara to the Queenston Heights, which face the plain bordering Lake Ontario, is seven miles. The general features of the region are shown in the bird's-eye view, page 973. The new excavation began again at the Queenston Heights, and gradually extended southward to its present limit at the Falls. The time of beginning was after the filling of the channel with drift, which occurred during the retreat of the glacier. The rate of progress in the exca-