

of these funnel-holes must have been the chemical and solvent action of the water from its own snowdrift, aided to some extent by the mechanical work of the frost.

ALFRED ELY DAY.

SYRIAN PROTESTANT COLLEGE, BEIRÛT.

ELEVATION AND SUBSIDENCE DURING THE GLACIAL PERIOD.

SIR,—In reply to the article by A. J. Jukes Browne (*GEOLOGICAL MAGAZINE*, December, 1890, p. 561), concerning high continental elevation of America with relation to the Glacial period, I may refer to my appendix in Prof. G. F. Wright's "Ice Age in North America," as containing a review of evidences of subsidence in the West Indies, cited in that article, probably contemporaneous with the elevation and glaciation of the northern part of North America. It was pointed out fifteen years ago by Dr. Ricketts (*GEOL. MAG.* Dec. II. Vol. II. 1875, pp. 573-580) that submergence of the Isthmus of Panama may have been an important element in the causes of the Glacial period; and at about the same time the collection by Dr. G. A. Maack of abundant Pleistocene fossils, "all living up to the present time," in the vicinity of the Panama railroad, and at many localities southward to the Atrato river, ranging in height up to at least 763 feet, while the lowest points of the interoceanic water-shed are less than 300 feet above the sea, gave proof that parts of this isthmus have been thus lately submerged (*Reports of Explorations for a Ship Canal, Isthmus of Darien, United States Navy Department, Washington, 1874, pp. 155-176*).

Nothing is more surely determined than the record of the Glacial period, as shown by glacial drift and striæ upon North America from the Atlantic to the Pacific, and from southern Illinois to the Arctic Sea, and upon north-western Europe from the British Isles to Germany and Central Russia, and northward across the Scandinavian peninsula. Some causes must have existed to produce the great climatic changes of this period. These causes seem to me to have been probably the great uplifts of the glaciated areas of which Professor Spencer has cited so much evidence, and the contemporaneous depression of the region of the West Indies and Isthmus of Panama, by which a part of the equatorial oceanic current that sweeps northward in the Gulf Stream would be permitted to pass into the Pacific Ocean, withdrawing a large portion of its heat from the North Atlantic area. Correlative northern elevation and southern subsidence, for both of which we have sufficient proof, would contribute almost equally to the climatic changes of the Ice age. This subject, and the probably contemporaneous uplift of a belt of land across the North Atlantic from France and Great Britain to the Færøe Islands, Iceland, and Greenland, as argued by Prof. James Geikie in his "Prehistoric Europe," I have discussed somewhat fully in the *American Geologist* for December, 1890, and the *American Journal of Science* for January, 1891, in the endeavour to ascertain the probable causes of the remarkable Quaternary changes of climate.

WARREN UPHAM.

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