feel much honored in receiving this award on behalf of Professor Lesquereux. His valuable researches not only contribute systematic descriptions of the American secondary and tertiary floras, but furnish almost the only data for comparing those floras with the plant-life from similar strata on this side of the Atlantic. All Professor Lesquereux's work is marked by such exactness and care, that I am glad we are thus able to honor it, and offer assistance in its progress.

THE DIFFICULTY OF PREVENTING THE OHIO FLOODS.

WILLIAM E. MERRILL, lieutenant-colonel U. S. engineers, in charge of the government improvements in the Ohio River, has, at the request of the editor of the *Cincinnati commercial gazette*, made public his views respecting the causes of the Ohio floods, and discussed the possibility of their mitigation in a letter published in the issue of March 8 of that journal.

In attempting to estimate the influence of forests, he says, experience has proved that the clearing and cultivation of level land have comparatively small effect upon floods, and may be left out of account: disastrous effects follow only when the hill and mountain sides are put under cultivation. The evil results of denuding the hills of trees are then illustrated by references to Spain, Palestine, Greece, parts of Italy and France, and the good results of reforesting the slopes of the French Alps noted.

Above Cincinnati the watershed drained by the Ohio comprises the western third of Pennsylvania, the whole state of West Virginia excepting four counties, the eastern part of Kentucky, and nearly the entire state of Ohio. Now, leaving out of consideration the more level portions of this area, the question is, whether its hilly and mountainous parts have been cleared of forests to such an extent as to materially affect its capacity to retain the rainfall, and so to call for legislative action to prevent greater calamities in the future. Col. Merrill answers this question emphatically in the negative. Speaking from an extended personal knowledge of the states of Pennsylvania, West Virginia, and Kentucky, which comprise the hilly portion of the Ohio basin, he says we are very far from having attained that state of forest destruction which would require the intervention of the government for the protection of the river-valleys in this manner. Any one who travels on the railroads which cross the Alleghanies sees that the country is still heavily wooded, while away from the lines of the railroad it is still a wilderness, except in a few isolated valleys. Even the removal of the merchantable timber from the country would do no especial damage, provided the underbrush and smaller trees were left to protect the soil. We thus far have no sure ground, he remarks, for asserting that man's interference has had any marked influence upon the discharge of the Ohio.

In sharp contrast with these views of Col. Merrill is an article on forests and floods in the *New York independent* for March 6 (p. 30), by Mr. N. H. Egleston of Washington, D.C., in which the basis of argument seems to be furnished by the map prepared by Professor Sargent to illustrate the census returns in regard to the condition of the forests, and more particularly by a careful examination of the amount of woodland now existing in the state of Ohio as compared with that of twenty years ago.

As the state is not much of it hilly, the argument appears in so far to be inconclusive, although the author states and explains the popularly accepted theory of the controlling influence of forests with great skill, and without hesitation ascribes the Ohio floods to their destruction. But Col. Merrill very pertinently remarks that the traditions of the aborigines show that even the great flood of 1884 was equalled by floods which occurred before white man's axe felled a single tree in the valley of the Ohio.

Whatever may be thought of the relative value of opinion upon this question, there is no doubt that Col. Merrill speaks as an expert and an authority when he treats the problem of controlling the surplus waters of the Ohio by artificial means. He says, the idea that it is possible to build a number of reservoirs in the mountains to store up water during freshets, and let it out during the scarcity of summer, is an old one, and one which has been discussed and abandoned in case of various European rivers. It was, moreover, advocated by the able engineer, Charles Ellet, jun., and vigorously pressed upon the attention of Congress. When the improvement of the Ohio was taken in hand by the government, after the close of the civil war, this scheme was practically investigated by W. Milnor Roberts, whose long engineering experience in railroad and canal construction in western Pennsylvania, and consequent familiarity with its topography, peculiarly fitted him for this work. After an exhaustive examination of possible sites, and estimate of cost of retaining reservoirs, which will be found in detail in his report to the chief of engineers under the date of April 30, 1870, he concludes thus: "My own careful investigations of the subject of controlling the floods of the Ohio by means of artificial reservoirs, which were made in 1857, satisfied my mind conclusively that such control by human means, attainable within practicable limits of cost, is impossible."

Mr. Roberts then examined another question, which was the practicability, not of controlling the floods at all, but of simply storing sufficient water to provide a supply to supplement the scarcity of the summer to such an extent that the summer flow at Wheeling should not fall below six feet. The reservoirs required to accomplish this were estimated to have a capacity of not less then a hundred and fifty billion cubic feet, and they must store the drainage from a watershed of not less than thirty-six hundred square miles. The estimated cost of accomplishing this with thirty reservoirs was sixty million dollars, a sum out of all proportion to the advantage to be derived from the improvement. Moreover, the dangers attendant upon such reservoirs are too great to justify the construction of even the few reservoirs required to secure a navigable stage of water, to say nothing of the vastly greater constructions which would be needed in any attempt to control floods. There is special insecurity necessarily inhering in the foundations of hydraulic work such as this, constructed in the bed and banks of running streams. Besides this, mention may be made of the interference which such reservoirs would cause in vested interests, such as mills, factories, railroads, canals, and rafting.

The latter portion of Col. Merrill's letter advises the city of Cincinnati to appoint a commission to define the lines of the river-front for high and low water, and to make it the duty of some public officer to prosecute in case of infringement on the free waterway, so that there may be no future obstruction of the river-channel. He shows that to the present time there has been no perceptible obstruction at this point. He further advises that the lower part of the city, next to the river, be filled by continuing the present slope of the river-banks upward to high-water mark; and then that those squares of the city which stand on the slope be devoted to business alone, and be so solidly built as not to be seriously damaged by an occasional flood, while the houses of the laboring population be removed to other parts of the city.

In conclusion, Col. Merrill says, in reply to the question which has frequently been put to him as to what the government is going to do to try to stop these floods, that, if the government be guided by his advice in this matter, it will do nothing, as the undoubted cause of the flood was the excessive fall of rain and snow; and no means of controlling this has yet been discovered.

AN EXPLANATION OF HALL'S PHENOMENON.[1]

MR. E. H. HALL's original experiment was as follows. A strip of gold-leaf was cemented to a plate of glass, and placed between the poles of an electro-magnet, the plane of the glass being perpendicular to the magnetic lines of force. The current derived from a Bunsen cell was passed longitudinally through the gold; and, before the electro-magnet was excited, two equipotential points were found by trial near opposite edges of the gold-leaf, and about midway between the ends. When these points were connected with a galvanometer, there was, of course, no deflection. A current from a powerful battery being passed through the coils of the magnet, it was found that a galvanometer-deflection occurred, indicating a difference of potential between the two points, the direction of the current across the gold-leaf being opposite to that in which the gold-leaf itself would have moved across the lines of force, had it been free to do so. On reversing the polarity of the magnet, the direction of the transverse electromotive force was reversed; and, when the magnet was demagnetized, the two points reverted to their original equipotential condition. Subsequent experiments showed that the direction of the effect differed according to the metal used. This effect was attributed by Mr. Hall to the direct action of the magnet on the current.

Mr. Bidwell claims that Hall's phenomenon might be completely explained by the joint action of mechanical strain and certain thermo-electric effects. The strain is produced by electro-magnetic action. It will be convenient to refer to the metallic plate or strip as if it were an ordinary map, the two shorter sides being called respectively west and east, and the two longer, north and south. Let the south pole of an electro-magnet be supposed to be beneath the strip, and let the strip be traversed by a current passing through it in a direction from west to east: then the strip will tend to move across the lines of force in the direction from south to north. Since, however, it is not free to move bodily from its position, it will be strained; and the nature of the strain will be somewhat similar to that undergone by a horizontal beam of wood which is rigidly fixed at its two ends, and supports a weight at the middle. Imagine the strip to be divided into two equal parts by a straight line joining the middle points of the west and east sides: then in the upper or northern division the middle district will be stretched, and the eastern and western districts will be compressed; while in the lower division the middle part will be compressed, and the two ends will be stretched. If, now, a current is passing through the plate from west to east, the portion of the current which traverses the northern division will cross first from a district which is compressed to one which is stretched, and then from a district which is stretched to one which is compressed; while in the southern division the converse will be the case. And here the thermo-electric effects above referred to come into play.

Sir William Thomson, in 1856, announced the fact that a stretched copper wire is thermo-electrically positive to an unstretched wire of the same metal, while a stretched iron wire is negative to an unstretched iron wire. From this it might be inferred, as Sir William Thomson remarks, that a free copper wire is positive to a longitudinally compressed copper wire, and that a free iron wire is negative to a longitudinally compressed iron wire; and experiment shows this to be the case. *A fortiori*, therefore, a stretched copper wire is thermo-electrically positive to a compressed copper wire, and a stretched iron wire is negative to a compressed iron wire. If, therefore, a current is passed from a stretched portion of a wire to a compressed portion, heat will (according to the laws of the Peltier effect) be absorbed at the junction if the metal is copper, and will be developed at the junction if the metal is iron. In passing from compressed to stretched portions, the converse effects will occur.

It follows from the above considerations, that, if the metal plate (which is subjected to a stress from south to north, and is traversed by a current from west to east) be of copper, heat will be developed in the western half of the northern division, and absorbed in the eastern half; while heat will be absorbed in the western half of the southern division, and developed in the eastern half. But the resistance of a metal increases

[1] Abstract of a paper read at the meeting of the Royal society, Feb. 21, 1884, by SHELFORD BIDWELL, M.A., LL.B.