

tricity not perceptibly different, when measured by a delicate galvanometer.

But under these circumstances if the long wire be coiled so as to act as a multiplier, its influence on the needle will be inexpressibly greater than the one so much shorter than it.

Further, from this we gather that for telegraphic despatches, with a battery of given electromotoric power, when a certain distance is reached the diminution of effect for an increased distance becomes inappreciable.

ART. XVII.—*On the Fossil Foot-prints of Birds and Impressions of Rain-drops in the Valley of the Connecticut*; by CHARLES LYELL, Esq., V. P. G. S.*

THE deposit in which these impressions, long known on account of the researches of Prof. Hitchcock, occur, is situated in a trough of hypogene rocks, about five miles broad, the strata, which consist of sandstone, shale and conglomerate, dipping uniformly to the east at angles that vary from 5° to 30° . Mr. Lyell first examined the red sandstone at Rocky Hill, three miles south of Hartford, in Connecticut, where it is associated with red shale and capped by twenty feet of greenstone. Many of the beds are rippled, and cracks in the shale are filled by the materials of the superincumbent sandy layer, showing, the author observes, a drying and shrinking of the mud while the accumulation of the strata was in progress. The next quarries he examined were at Newark, in New Jersey, about ten miles west from New York city. The excavations are extensive, and the strata dip, as is usual in New Jersey, to the northwest, or in an opposite direction to the inclination in the valley of Connecticut, a ridge of hypogene rocks intervening. The angle is about 35° near Newark. The beds exhibited ripple-marks and casts of cracks, also impressions of rain-drops on the upper surface of the fine red shales. Mr. Lyell states, that he felt some hesitation respecting the impressions first assigned to the action of rain by Mr. Cunningham of Liverpool, but he is now convinced of the justness of the inference, having observed similar markings produced on very soft mud by rain at Brooklyn, in Long Island, N. Y. On the same mud were the foot-prints of fowls, some of which had been made before the rain and some after it.

* Communicated to the Geological Society of London, and extracted from Vol. III, No. 91, of their Proceedings. We had not seen this abstract of Mr. Lyell's paper when the article on the Ornithichnites appeared in our last number, or we should have united it with the other matter of that paper.—Eds.

Mr. Lyell next visited the red and green shales of Cabotville, north of Springfield in Massachusetts, where some of the best Ornithichnites have been procured, chiefly in the green shale. The dip of the beds is 20° to the east, a higher inclination, the author says, than could have belonged to a sea-beach. He observed in the same quarries ripple-marks as well as casts of cracks, and he was informed that the impressions of rain-drops have likewise been found.

In company with Prof. Hitchcock, Mr. Lyell afterwards examined a natural section near Smith's Ferry, on the right bank of the Connecticut, about eleven miles north of Springfield. The rock consists of thin-bedded sandstone with red-colored shale. Some of the flags are distinctly ripple-marked, and the dip of the layers on which the Ornithichnites are imprinted, in great abundance, varies from eleven to fifteen degrees. Many superimposed beds must have been successively trodden upon, as different sets of tracks are traced through a thickness of sandstone exceeding ten feet; and Prof. Hitchcock pointed out to the author that some of the beds exposed several yards farther down the river, and containing Ornithichnites, would, if prolonged, pass under those of the principal locality, and make the entire thickness throughout which the impressions prevail, at intervals, perhaps twenty or thirty feet. Mr. Lyell, therefore, conceives that a continued subsidence of the ground took place during the deposition of the layers on which the birds walked.

It has been suggested, but the opinion has not been adopted by Prof. Hitchcock, that the eastward slope of the beds represents that of the original beach. With a view to this question, Mr. Lyell examined the direction of the ripple-marks, and found that it agreed with the dip, or was at right angles to the supposed line of beach; but he adds, though this agreement presents a formidable objection to the suggestion above alluded to, if the ripples were produced by waves, yet it does not disprove the opinion, as the ripples do not exceed in dimensions those which are produced by sand blown over a muddy beach, and often distributed at right angles to the coast-line. Instances of this effect of the wind Mr. Lyell has remarked along the shores of Massachusetts. Nevertheless he is of opinion that the rippled layer of sandstone in question contains too much clay to have resulted from blown sand, and he is disposed to think that in most of these localities the strata have been tilted, instances of such disturbance having been pointed out to him by Prof. Hitchcock in the state of Massachusetts, and by Dr. Percival near New Haven, in Connecticut. In reference to this subject, he says, that a few miles from Smith's Ferry, a conglomerate, several hundred feet thick, containing angular and rounded fragments of trap and red sandstone, the base being sometimes a vesicular trap and trap tuff, passes

upwards into the very flags on which *Ornithichnites* occur; and from this he infers, that there were eruptions of trap, accompanied by upheaval and partial denudation, during the deposition of the red sandstone.

With respect to the impressions having been made by birds, Mr. Lyell states, that until he examined the whole of the evidence he entertained some scepticism, notwithstanding the luminous account given by Prof. Hitchcock. In proof of their being the foot-prints of some creature walking on mud or sand, he mentions, 1st, the fact of Prof. Hitchcock's having seen two thousand impressions, all, like those he had himself examined, indented in the upper surface of the layer, the casts in relief being always on the lower surface; and 2dly, that where there is a single line of impressions, the marks are uniform in size, and nearly uniform in distance from each other, the toes in the successive steps turning alternately right and left. Such single lines, Mr. Lyell says, indicate that the animal was a biped, and the trifid marks resemble those which a bird leaves, there being generally a deviation from a straight line in any three successive prints; and his attention having been called to indications of joints in the different toes, he afterwards clearly recognized similar markings in the recent steps of coots and other birds on the sands of the shores of Massachusetts. Prof. Hitchcock has shown, that the same impression extends through several laminæ, decreasing in distinctness in proportion as the layer recedes from that in which it is most strongly marked, or in proportion as the sediment filled up the hollows and restored the surface to a level; and Mr. Lyell states, that he has observed a great number of instances of this fact.

He also says, that he can scarcely doubt that some of the impressions on the red sandstone of Connecticut are not referable to birds, but he believes that the gigantic ones described by Prof. Hitchcock are *Ornithichnites*. At Smith's Ferry they are so numerous that a bed of shale many yards square is trodden into a most irregular and jagged surface, so that there is not a trace of a distinct footstep; but on withdrawing from this area to spots where the same tracks are fewer, the observer, Mr. Lyell says, is forced to admit that the effect in each case has been produced by this cause.

On examining the shores on some small islands about fifteen miles southeast from Savannah, the author was struck with the number as well as the clearness of the tracks of raccoons and opossums imprinted in the mud during the four preceding hours, or after the tide had begun to ebb. At one spot, where the raccoons had been attracted by the oysters, the impressions were as confused as when a flock of sheep has passed over a muddy road; and in consequence of a gentle breeze blowing parallel to the line of cliffs composed of quartzose sand, the tracks had in many places already become half filled with blown sand,

and in others were entirely obliterated; so that if the coast should subside, the consolidation of this sand would afford casts analogous to those of Storeton Hill in Cheshire, yet the impressions had been made and filled in a few hours.

When considering the broad question whether the fossil foot-prints were made by creatures walking on mud or sand after the ebbing of the tide, Mr. Lyell reminds his readers of the fact that in the United States, as in Saxony and Cheshire, the tracks in sandstone and shale are accompanied by littoral appearances, as ripple-marks, the casts of cracks in the clay, and often by the marks of rain.

In regard to the age of the red sandstone of the valley of the Connecticut and New Jersey, the author states he has nothing to add to what had been previously advanced, by which its position had been shown to be between the carboniferous and cretaceous series. In the neighborhood of Durham, Connecticut, he had collected in the sandstone, fishes of the genera *Palæoniscus* and *Catopterus*, but no other organic remains, except fossil wood.

In conclusion, Mr. Lyell remarks, 1st, that the *Ornithichnites* of Connecticut should teach extreme caution in inferring the non-existence of land animals from the absence of their remains in contemporaneous marine strata; 2dly, that when this red sandstone of Connecticut was deposited, there was land in the immediate vicinity of the places where the *Ornithichnites* occur; and that but for them it might naturally be inferred that the nearest land was several miles distant, namely, that of the hypogene rocks which bound the basin of the Connecticut. Now, the land that caused the sea-beach, Mr. Lyell says, must have been formed of the same sandstone which was then in the act of accumulating, in the same manner as where deltas are advancing upon the sea.

In a postscript, Mr. Lyell states, that subsequently to writing the paper, he had read the luminous report of Mr. Vanuxem* on the *Ornithichnites* described by Prof. Hitchcock, and though it agrees in substance with his own account in some particulars, yet that he has left his notice as it stood.

ART. XVIII.—*Bibliographical Notices.*

1. *Zoology of New York, or the New York Fauna, comprising detailed descriptions of all the Animals hitherto observed within the State of New York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations; by JAMES E. DE KAY. Part I, Mammalia. pp. 146, 4to, plates.*—The mammiferous

* See this Journal, Vol. xli, p. 165.