We are now prepared to investigate the value of the telegraphed result from Texas. Any one who will examine the weather maps, now sown broadcast over almost the whole country, will find that on the 11th instant there was a natural rain which extended over the whole of Texas and adjacent regions. One thing seems very evident, that absolutely no rain can be obtained out of a dry atmosphere. If the explosions can produce rain in limited quantities, yet their influence must always be exceedingly slight, and the expense of the explosions must always be all out of proportion to the amount of good done. Professor Harrington has well said that these experiments begin at the wrong end. The time may be ripe for experimenting in the atmosphere upon the cause of rain, about which we now know practically nothing. It must be conceded that until we do first experiment upon the cause of rain, all time and money used in making gross explosions will be wasted.

H. A. HAZEN.

Washington, D.C., Aug. 17.

P. S. — Since writing the above, a telegram from Midland, dated Aug. 19, states that several more preliminary explosions were made on Aug. 18, and that immediately thereafter rain began falling and continued over four hours. An examination of the weather maps for Aug. 18 has shown that the rain began, to the north of Texas, at least eleven hours before the explosions, and covered an area of over 800,000 square miles. The final tests were to be made on the 20th. H. A. H.

Experiments on Snake Locomotion.

IT is a well-known fact that a snake moves along over the ground by means of adjustable plates or scutes situated on the ventral surface of the body. How the movements of these scutes succeed each other, and what relations the different convolutions of the body bear to one another, are not so satisfactorily known. Whoever has examined the mechanism of the scutes will, I think, come to the conclusion that they must be moved by the costal muscles, and that this movement must consist in a posterior depression by which the scute offers an opposing surface to the ground. In all probability this depression is both downward and backward, thus imparting a slight forward impulse to the body. If this view of the case is correct, we would naturally expect that the act of locomotion would consist in some sort of fusion or succession of these minute individual impulses. Owing to the rapidity with which these movements are normally executed it is impossible to analyze or define their exact nature, and accordingly experiment seems to offer the only trustworthy guide to a solution of the problem. In experimenting, however, we are encountered with great difficulties at the very outset.

If we could succeed in recording the movements of an animal by means of apparatus, the construction of which was ever so delicate, can we rely on this record as a faithful expression of the natural and unimpeded movements of the animal? We can hardly feel at liberty to do so. There are at least two causes which may vitiate the results: (1) the animal is excited and annoyed by the experiments and does not act naturally; (2) the apparatus used in the experiment may directly impede the organs in the discharge of their normal functions. But while these difficulties render it impossible to obtain a record which is trustworthy in all respects, yet approximate results may be obtained which will lead up to a correct solution in the end.

In considering the locomotion of the snake, it may be well first to state what we know and what we do not know. We know that the snake generally moves on a horizontal or inclined plane, rarely elevating any part of the body to a very considerable distance above that plane. It sometimes moves with its body straightened and in a straight line, but far more frequently the body is placed so as to resemble a sinusoid, and its movements have a lateral and a direct component. The larger convolutions of the body occur in those portions which have the greatest mean diameter. The convolutions do not form simultaneously, but each travels the whole length of the body, like a wave of water, being at no two consecutive moments composed of the same parts. These waves succeed each other on opposite sides of the body, thus producing a reciprocal curve. Each wave travels from the head towards the tail, and drives its predecessor of opposite phase before it until it disappears at the tail. At times the curves do not shift to alternate sides of the body, but successive curves are formed on the same side. This motion, be it observed, is totally distinct from the reciprocal curvings described above. So much for what can be directly observed. But we cannot tell by direct observation the curves which different parts of the body would describe were they to mark the surfaces over which they move. Nor can we observe the movements of the scutes, or their correlations with the movements of the body as a whole. If we are to understand these activities, we must do so by experiment.

The following was the method of experiment employed. Short pieces of thread were run through bits of sponge saturated with ink, and these were tied around the body of the snake so that the sponges would come on the ventral surface. When these were securely tied the animal was placed on a strip of coarse paper and allowed to move. So long as the sponges were properly supplied with ink every movement made by the parts of the body thus provided was marked on the paper. Now if the different sponges were soaked with ink of different color, the simultaneous movements of different parts would be recorded, and, theoretically, with a sufficient number of sponges placed at proper intervals we would secure a complete record of all the bodily movements during a sustained period of locomotion. Such a record, however, it is impossible to obtain, for reasons which need not be mentioned.

The curves obtained by this method were by no means uniform, but varied both with the direction and velocity of the movements, and apparently with the caprice of the animal. The separate curves described by different parts of the body cannot be said to be characterized by any marked idiosyncracies. On the contrary, they appear to vary at random, now being marked by acute angles followed by beautifully rounded sinuosities, which in turn may be succeeded by protracted and irregular curves or at times figure-of-eight tracings. There is this distinction, however, between the curves described by the middle of the body and those of the distal parts. They have not so great an amplitude and are less variable. Contrary to what we would naturally expect, the synchronous curves described by different parts of the body have no discoverable agreement either in phase or in form.

From this description it might be inferred that very little of value could be derived from a study of such curves. But further study shows this inference to be ill-sustained. In interpreting the curves it is well to remember that they do not represent perfectly normal movements, because the scutes over which the sponges were tied were impeded in their action, and because rough paper is even smoother than the average ground over which the snake moves. Owing to this last circumstance the scutes would slip, and the curves would thus be shorter.

After making due allowance for the conditions which embarrass the experiments, we may perhaps still speak with some degree of confidence as to the general results, and possibly discover the existence of some fundamental laws. Perhaps the most striking fact about all the curves is, that, with very rare exceptions, they are described on opposite sides of an ideal line which may be called the axis of motion. While they demonstrate that the snake's body is capable of an almost infinite variety of movements, yet lateral movements generally prevail. There is also a tendency to consecutive repetitions, sinuosities following sinuosities, and angularities following angularities. The most irregular curves are described when the animal executes slow and hesitating movements. In this case the curves may be extended on both sides of the axis of motion, or confined to one side, when the curve is a tolerably regular succession of semicircles whose adjacent arcs form cusps. During rapid motion the sinusoid is by far the most common curve described. In fact, it may be regarded as the typical curve described by the snake's body.

It is instructive to note that when the curve assumed by the body is a sinusoid, then the curves described by different points of the body are sinusoids. The relation becomes intelligible when we reflect that the curves of the body partake of a wave-like motion, each particle vibrating, as it were, from the crest of one convolution across the axis of motion to the crest of a succeeding convolution of opposite phase, and all the while progressing in a general direction parallel to the axis of motion. At this point it may be asked, what advantage is secured by this curvilinear motion? The chief advantage seems to be that those portions of the body placed transversely to the axis of motion furnish better fulcra from which the anterior parts of the body may be projected forward. If this is the correct explanation, then, during the forward movement of that part of the body anterior to the transverse flexure, the scutes are for the most part passive, and the anterior parts are projected by the median muscles. This seems to be a good reason for believing that the scutes do not act in continuous succession from before backwards, but intermittently and perhaps to some extent simultaneously, being interrupted by shoves and pulls which annul and complicate their action. The problem of their motion, however, is a difficult one, and more experimentation is needed before the laws of their action can be confidently and fully formulated. J. LAWTON WILLIAMS.

Hornellsville, N.Y., Aug. 18.

Black and Bright Bulb Thermometers in Vacuo.

IN reply to an inquiry in this journal for Aug. 7, I would say that the formulæ for these radiation thermometers will be found in the "Annual Report of the Chief Signal Officer for 1885," pp. 131-134. Professor Ferrel has also made an exhaustive study of a special investigation of a large number of these thermometers, which will be found in "Professional Papers, Signal Service," XIII., pp. 34-50.

Several notices have appeared in *Nature* from time to time. It would seem that serious discrepancies have been found in these instruments, and it is still a mooted question as to their source. Professor Ferrel found, as was to be expected, that the ventilation of the bulbs was a most important factor. H. A. HAZEN.

Washington, D.C., Aug. 18.

AMONG THE PUBLISHERS.

THE most timely feature of the September number of the *New England Magazine* is an article on the late "Edward Burgess and His Boats." The writer is A. G. McVey, the yachting editor of the Boston *Herald*.

—D. C. Heath & Co., Boston, will issue, about the first of September, "Andersen's Marchen," selected, arranged, and edited, with notes and vocabulary, by Professor O. B. Super of Dickinson College, Pa.

—In the *Atlantic Monthly* for September John Fiske has a paper on "Europe and Cathay," which discusses the reasons why early Norse discoverers of America were not its real discoverers. In the same number is a description of the Japanese Feast of Lanterns and the Market of the Dead, by Lafcadio Hearn.