LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The editor will be glad to publish any queries consonant with the character of the journal.

Tornadoes: Fact vs. Fiction.

THERE is no subject in meteorology of more absorbing interest than this. As our knowledge of the environment of tornadoes increases, there must necessarily be modifications in our views of their origin. One of the more recent and most significant of these changes has been the transferrence of the cool northerly wind, meeting the warm south wind, from the earth's surface to the upper regions, where it is said to overflow the lower current, and produce an unstable equilibrium in the atmosphere. It would seem as though no subject can demand, more strongly than this, a solid substratum of fact; and yet, strange to say, the theories and speculations about these terrible visitors have been far more extensive than the facts. This seems a favorable time to state a few of the more prominent facts and seeming fictions. The facts are these: —

1. It has been well said that the most important recent development has been the fact that tornadoes occur, not at the centre of a general storm, but about four hundred miles to the south-east. This fact was known fifteen years ago, but was first strongly emphasized in March, 1884.

2. All currents in this region, even up to a great height, are from the south before the tornado, as is well known from observations of the upper clouds.

3. The tornado invariably moves to the north-east; and if, as some believe, it takes its motion in the upper current, that must be from the south-west, and cannot be from the north even after the tornado.

4. The pressure rises in a tornado, as has been observed a few times in it, and it invariably rises at the centre of a thunder-storm, which frequently develops into a tornado.

5. That some other force than a violent gale blowing into a partial vacuum is concerned in the destruction, is well shown by the fact, that of two free barrels side by side, one of which was empty and the other full, the former was left undisturbed, while the other was completely obliterated. Fowls have been stripped of their feathers, and people deprived of their clothing, which could not be brought to pass by the most violent gale.

6. The tornado is extremely sudden, and, advancing without any warning, it interjects itself into a region of gentle southerly winds. After it has passed, the southerly wind almost at once again predominates. The whole appearance is as though a disturbance, largely having its own source of energy, had suddenly projected itself into a quiet air, and passed on without bringing about any but a momentary change.

7. Its velocity is nearly double that of the accompanying general storm.

8. Numerous thunder and hail storms are an invariable accompaniment.

A few fictions are the following: —

1. Professor Ferrel states on p. 327, "Recent Advances in Meteorology," that in the tornado there is an unstable equilibrium due to "the large vertical gradient of temperature decreasing with increase of altitude."

2. Mr. Finley, in *Science* of Feb. 1, thinks that this same condition must be found, not in the tornado, but in the region just around it.

3. This abnormal decrease of temperature is due to cold air overrunning warm. This is really an impossible condition, since the denser cool air must always underrun that which is lighter and warmer. That a most extraordinary decrease of temperature and most extreme unstable equilibrium, possibly five hundred times as great as can ever occur under natural conditions, does not produce a destructive whirl, advancing scores of miles from its origin, is well shown by the seas of fire extending many square miles in forest clearings. Here there is a temperature at least 1000° higher than that of the air two or three hundred feet above it. There are occasional whirls set up over such a fire, but they are short-lived, and extend only to its edge.

4. There is a violent uprush of air at the tornado centre. As we have just seen, the tornado is not at the storm-centre, but four hundred miles to the south-east, where there is no rising tendency in the air.

5. There is a uniform flow of northerly upper currents over an extended region, and tornadoes are produced at spots one hundred miles apart by the breaking-through of the warm lower air.

6. The tornado, in its onward motion dipping here and there for one hundred miles and more, has its energy kept up by a continual upsetting of the equilibrium, conveniently occurring just in front of it exactly at the moment of its advance, and nowhere else. These latter certainly have no facts to sustain them, and must be regarded as impossible or highly visionary till observations in the cloud region give still further facts. Until these facts are had, it is unsafe to theorize.

H. A. HAZEN.

Washington, Feb. 4.

A Deadly Gas-Spring in the Yellowstone Park.

THE familiar fable of the upas-tree, living in a valley of death wherein all life was killed by its deadly exhalations and the ground was strewn with the bones of its victims, has been proven, like many a traveller's tale, to be a highly colored and exaggerated account of a natural phenomenon. The upas-tree is now well known to have poisonous sap, but not poisonous vapors. But the story survives in the accounts given of the Death Valley of Java, which it was long believed no traveller could cross, "wherein every living being which penetrated the valley falls down dead, and the soil is covered with the carcasses of tigers, deer, birds, and even the bones of men, all killed by the abundant exhalations of carbonic-acid gas, with which the bottom of the valley is filled." Such is the description given by Lyell[1] of this famous valley; while another locality is described as a place where "the sulphurous exhalations have killed tigers, birds, and innumerable insects, and the soft parts of these animals are perfectly preserved, while the bones are eroded and entirely destroyed. The researches of Junghuhn[2] have shown that these accounts are much exaggerated, the "valley of death" being a funnel-shaped depression but one hundred feet in diameter, instead of a valley half a mile across. In the bottom of this depression there is a hole about fifteen feet in diameter, from which gaseous emanations are given out, which at times accumulate to a depth sufficient to envelop and suffocate animals on the bottom of the hollow. Repeated visits by Junghuhn, extending over a period of twelve years, showed that the amount of gas varied greatly from time to time, but rarely ever rose over two feet and a half above the bottom. At the time of his earlier visit, he found the body of a Javanese native in the depression, but experienced no difficulty or oppression while there himself. This same body was still undecomposed, owing to the preservative effect of the layer of gas, when he repeated his visit eighteen months later. The only other remains seen during his subsequent visits were the carcasses of six swine which were decomposed and putrid. At this time the absence of the gas was shown by the presence of a crow feeding upon the dead bodies.

Though thus shorn of much of its former glory, this Pakaraman, or poison-hole, is the largest and most dangerous of the gas-springs or mofettes of Java, and indeed of the world, and really deserves the title of a natural death-trap. Though such emanations are common in all volcanic regions, this has been the only place known where the gases have accumulated, and caused the death of the larger animals.

In the Yellowstone National Park, now so well known as the wonderland of America, there is a place equalling this famous death valley, and where the gaseous exhalations have proved fatal to numerous bear, elk, and many smaller animals.

This place, to which the appropriate name of "Death Gulch" is given, was discovered by the writer during the past summer (1888), while making a geological examination of the region for Mr. Arnold Hague, the geologist in charge of the survey of the park. It is situated in the extreme north-eastern portion of this reservation, a

[1] Principles of Geology, 1878, i. p. 590.

[2] Java Seine Gestalt, etc., German translation by Hass Karl, ii. p. 202.