The past surrendered to the present's power,
And I, to-day, grudged not the grave its trust.

Instead of that, the thought flashed like a bolt,
Shocking my sense of faith and love sincere, —
Nay, like a crime from which I would revolt, —
"The day has come you would not have her here."

I had been sure, with grief at awful height,
That other love could never, never be;
Both law and gospel giving ample right,
I start to-day at time's strange alchemy.

Charlotte Fiske Bates.

HURRICANES.

aka Tornadoes

THE general physical order of our universe is singularly well suited to the needs of organic life. Death comes in most cases from the forces within the being, or from the action of other organic forms. Only now and then do we find the inorganic machinery of the earth compassing at once the wide-spread destruction of living creatures. These departures from the calm order of physical events of our earth fall into a few classes, and are all momentary in their action: they are the earthquake, the lightning, and the violent movements of the atmosphere, known as cyclones, typhoons, or hurricanes.

Although these rude modes of action of the natural forces fill a large place in the fears of man, they are so uncommon that few of those who read these lines will have seen any deadly effects from their action. It is rather because of their uncommonness that they have an importance to us; if they were very frequent events, if much of the death in the world came through them, familiarity would have made them contemptible. A single bad sewer may, in its time, kill more people than all the shocks of earth and air within the bounds of an empire; but the great incidents of nature are picturesque; they have the noble charm that belongs in things terrible; and so I may fairly hope for an interest in this paper that would not be given the disorders and ravages of a Cloaca Maxima.

Our own country has a more direct interest in the matter of violent wind storms than in any other of the cataclysms of nature. We have long been spared serious ravage from earthquakes, and though lightning probably does more effective work in the eastern half of North America than in any other country, its destruction here as elsewhere is of a sporadic sort, never leading to wide-spread ruin; but in all the region of the Western prairies we have the frequent visitation of hurricanes, bringing about catastrophes more terrible to the imagination, less limitable by any human skill, more utterly destructive to all the works of man, than any other accidents of nature. Several times in each summer season we hear that some of the new settlements in the region of the Mississippi have been visited by one of these meteors, and that the very face of the earth has been blown away; villages, fields, and forests flying before it as the grass before the blast of the cannon. The only mitigation to the horror is the

narrowness of its path: while an earthquake may devastate a hundred thousand square miles by its shocks, sometimes the area of a hurricane's ravages is not over a mile in width and ten miles or less in length. If space admitted, it would be interesting to trace in detail the circumstances that attend these calamities; they afford scenes of terror to which the most dreadful earthquake can scarcely furnish a parallel; but for our purpose it will be sufficient to note the purely natural side of the convulsion, leaving its woful incidents out of sight.

All the wind storms of the hurricane class, as far as their most evident phenomena are concerned, conform closely to a single type. Of their exact physical history we are yet in much ignorance. Such conditions as they bring about are not favorable to close observations; no mind can see calmly when the body is in the very hands of death; but out of the cloud of fables that gather around such tempests we can collect facts enough to make a tolerably clear picture of the events that hurriedly succeed each other in these catastrophes.

In the season of hot weather in the central part of the Mississippi Valley, there often come successions of days when the atmosphere is not stirred by the winds, but remains as still as the air of a cave. Despite the steady gain in the heat, the sky stays cloudless, or at most is flecked by those light clouds that lie five miles or more above the surface of the earth. All nature seems cowed beneath the fervent heat, yet there is nothing of distinct portent in earth or air. At last, towards evening there may be seen a sudden curdling of the western sky; in a few minutes the clouds gather, coming from nowhere, growing at once in the lurid air. In less than half an hour the forces of the storm are organized, and its dreadful advance begins. If we were just beneath the gathering clouds we would find that the air over a space a mile or so in diameter was spinning around in a great whirlpool, and while the revolving mass slowly advanced, the central part moved rapidly upwards. Beginning slowly, all the movements of the storm, the whirling action, the vertical streaming of the air, its onward movement, all gain speed of motion with astonishing rapidity. In a minute or two some cubic miles of air are in a state of intense gyratory movement, mounting upwards as violently as the gases over a volcano. To replace this strong whirling uprush, there is an indraught from every side towards the centre of the whirlwind; and as this centre moves quickly forward, the rush of air is strongest from behind towards the advancing hurricane. The rate at which the storm goes forward is very variable, though it is generally as much as forty to one hundred miles an hour; but this is not the measure of its destructive power. The rending effect of the storm is much greater than would be given by a simple blast of air moving at this speed. Much of this peculiar capacity for destruction may perhaps be due to the gyratory motion of the wind in the storm centre, which on one side of the whirlwind adds the speed arising from its circular movement to the translatory velocity of the whirlwind itself. Some of the records tell us that houses with closed windows have been known to burst apart, as if from an explosion of gunpowder, while others, that had their doors and windows wide open, remained essentially unharmed. It has been conjectured that this action may be due to a sudden rarefaction of the air on the outside of the building; but this cause cannot be sufficient to produce such effects, and if such explosions occur the cause must be looked for elsewhere. After the storm is once developed, it seems very quickly to acquire its maximum of destructive power and its speed of translation. At the outset and during the period of most efficient action, the strip of country affected is generally very

narrow, not often exceeding a mile in width; as the storm advances the path seems gradually to grow wider, and the gyratory movement as well as the translatory motion of the meteor less considerable, until at last it fades into an ordinary thunder-storm, or dies into a calm. Through the whole course of the hurricane, and especially during its closing stages, there is generally more or less rain and hail. Storms of this class are so exceptional in all their features that it is not yet quite certain to what combination of causes they are due. To give the reader what light we have, it will be necessary to do with them what the inquirer will find it well to do with all the large phenomena of nature: first, to examine their relations to other similar phenomena, and second, to study the law of their geographical distribution.

These storms differ from our ordinary atmospheric disturbances in the following ways: Ordinary winds are produced by an excess of atmospheric pressure in the regions whence they blow. The wide-ranging steady winds flow out from regions of high barometer to those where lower pressure prevails. They rest upon gravitative forces, flowing in obedience to the same force that impels streams to the sea; it is evident that they have no distinct relation to hurricanes. Besides this class of general, steady winds we have the class of cyclones; storms belonging to this group are almost always developed over the surface of seas, — usually, if not always, near the land. They are like hurricanes in the general laws of their motion, having a whirling movement and a forward movement of the centre; they differ, however, from hurricanes in their vastly greater volume and in the enormously greater length of their courses. It seems doubtful whether there are gradations of size between the largest hurricane and the true cyclone; related in every other feature, these storms are distinct in the magnitude of their phenomena. None of the hurricanes of the Mississippi Valley, of which I have seen accounts, approach the typical cyclone in size, except, perhaps, the memorable storm of July, 1857. This singular meteor swept from the region west of the Mississippi across the continent to the seaboard, and thence far out towards Europe; it was at points a hundred miles wide, and save for the rapidity of its translation was a normal cyclone of great power. Yet I fail to find a series connecting the largest of our ordinary hurricanes with this great storm. In the ascending scale of size our hurricanes shade obscurely into the greater cyclone. In the descending scale they pass in the same obscure manner into the little whirlwinds which may often be seen on our streets and fields. In any time of bright sunshine and moderately still air we may see these last-named little dancing storms; they never seem to attain a very great size, the largest being a score or two feet in diameter, and their lifting power very slight. In many other respects, they closely resemble hurricanes: there is the same upward, whirling motion, and the same onward moving of the axis of the column, but all the dimensions are in miniature. Although on the land these whirlwinds are small, over the surface of the tropic seas and in the Mediterranean they attain a large size, and take on the character of water-spouts. These in violence resemble our hurricanes, but in dimensions they are much less considerable than the ordinary meteor of the Mississippi Valley type. Yet their lifting power is far greater than that of the small whirlwinds of the land; the latter can raise clouds of dust or small light objects, while there can be no reasonable doubt that the water-spout whirlwind can lift large bodies of water to a great height above the sea.

Thus we see that we have three or more divisions in the class of whirlwinds, which give a great series of circular

storms, ranging in size upwards from the familiar dust whirls of the land to the water-spout of the sea, then to the hurricane, and still further to the vast cyclone. All these storms are akin in their essential features, differing only in the magnitude and intensity of the disturbances they bring about.

Having traced in this brief and incomplete manner the classification of circular air storms, let us next look at the circumstances of their distribution. A study of these conditions shows us that these whirlwinds are not developed except in regions where great heat prevails in times of comparative calm. They do not occur in high latitudes, or indeed beyond the tropics, except during the summer season.

Limiting ourselves to the forms of these storms that occur in this country, we further perceive that they are encountered only in regions of level surface, and that they are practically limited to districts that are not forest clad, or to wooded regions near the line of treeless plains. Storms having the general aspect of hurricanes, but wanting their very great destructive power, occur occasionally all over the United States east of the Rocky Mountains. To cite but one case, there have been two hurricanes in the valley of the Mystic River, near Boston, within thirty years, that did a good deal of damage to vegetation and to weakly constructed houses; one or two lesser blasts of the same nature have ravaged this valley in other years. The careful study of one of these meteors, which was made by Professor Eustis, of Harvard College, shows that it was distinctly a whirlwind storm, essentially like the Western hurricanes. But the hurricane as a normal feature in the atmospheric economy is limited to the central part of the Mississippi Valley; this hurricane country extends from Texas and Mississippi in the south well up to the head-waters of the great stream. Its borders are not clearly defined, for the region has in parts not been long enough dwelt in by civilized man to show us the true character of its conditions, but it seems to include all the treeless district that lies in the far west and northwest of our country. Eastward of this region the hurricanes become less powerful, and fade away into the ordinary thunder-gusts, which have something of the same character, but less concentration and more diffused energy. In the Rocky Mountains, though small whirlwinds are very common, being often a most conspicuous feature of the landscape, they never take the form of hurricanes.

This brief sketch of the distribution of hurricanes makes us ready to look to the nature of the causes that set these dreadful engines in motion. Several rather vague theories have been presented to us, but they deal in glittering generalities. The only hypothesis worthy of the name is one suggested by the late Mr. Thomas Belt, author of that charming book entitled The Naturalist in Nicaragua, which is essentially as follows: As is well known, the direct heat rays of the sun pass through the atmosphere with extreme ease; this is shown by the low temperature of the air in its upper regions. Even in the lower regions of the atmosphere, if the air be dry, or if its moisture be in the state of vapor insensible to the eye, the heat goes through it like water through an open sieve. It is quite otherwise with radiant heat. When the surface of the earth becomes heated the heat thrown off by radiation does not so easily escape; the considerable amount of moisture resists the passage of the heat into the upper region of air, so that the lower stratum of the atmosphere may acquire a high temperature, while the upper regions remain very cold. Now the difference between these regions of lower heated and cold upper air inclines them to change their relative positions: the hot lower air tends to ascend, and the

cold air above seeks by its greater gravity to descend to the surface of the earth. All the movements of the air are in the main due to this peculiar set of conditions, but generally they produce winds of a more or less continuous character, varying in permanence from the ceaseless trade-winds that have blown from the beginning of geological times to the transitory breezes of a summer day. When there are strong winds blowing the air is in a state of constant disturbance, and a sufficient mingling of air from the two regions takes place to remove all strain; but when, in times of long-continued calm, no mingling is allowed, the heated and the cooled levels are kept in their places, until the strain becomes very great. At last some small accident starts an upward stream of air at one point; up this column the heated air rises with a rush, and down the sides of the column the cooled air finds its way; with great swiftness the long-accumulating strain is broken, and large masses of the two diversely heated airs exchange places. The whirling motion of the ascending air is explained by the common laws of passage of one mass of fluid through another. Something analogous to it may be seen in the gyratory movement of water flowing out of a wash-bowl through the opening at the bottom. When the diameter of the storm is great, as in a cyclone, the difference in the rotary motion of the earth in the northern and southern parts of the storm causes it to whirl in a fixed way: always going round in one direction in the northern hemisphere, and in the reverse way in the southern hemisphere. In the smaller spirals, however, of the hurricane and water-spout, or the small land whirlwinds, the twist may take place in either direction. This hypothesis will help us to explain the peculiar seasonal and regional distribution of hurricanes and other circular storms. The reason that they do not occur in hilly or mountain countries may be found in the fact that in such regions the difference of temperature between the hill-tops and valleys, or between the sunny and shaded sides of the declivities, causes a motion of the air that prevents the formation of the intense atmospheric tension necessary to the creation of the characteristic hurricane. These slight movements bring about an equilibrium of the upper and lower levels of air before any cataclysm is possible. The covering of forests or even the ordinary surface of cultivated land prevents the earth from becoming intensely heated by the sun's rays, so that the lower air is not brought to so high a temperature as it is over low and therefore easily heated plains. Thus the conditions that this hypothesis requires are best met in the regions where these storms exhibit their most intense power. Although this view was only outlined by Mr. Belt and is somewhat modified in this statement, we see that the facts correspond with the theory in a closer way than they commonly do in the case of a new hypothesis. It may not apply so well to the other genera of circular storms, the whirlwind and water-spout, or the vast cyclone. Yet, taken altogether, it seems more reasonable than any other hypothesis that has yet been brought forward. It is only necessary to suppose that the bodies of air involved in the disturbance differ in mass or depth to bring all the various causes of circular storms within the bounds of the explanation. In the trifling whirlwinds the depth and mass of the heated air are probably very slight, and the energy with which the air streams upward is relatively insignificant; in the cyclone a vast body of air, of profound depth, joins in the movement, and gives the storm its magnitude.

Circular storms do not seem to be limited to our earth; they evidently occur in the atmosphere of the sun on an infinitely vaster scale. The sun spots appear to be descending whirlwinds of

vast dimensions, and the flame-colored protuberances that are so conspicuous in a total eclipse are probably gigantic uprushes of the intensely heated gases that wrap the surface of the solar sphere. The great dark spots on the surface of Jupiter, which appear from time to time to be the puzzle of astronomers, may have the same general nature. Like those of the earth in their general physical character, they differ in their origin; on the sun, and probably on Jupiter, they are due to the heat of the sphere on which the atmosphere of those bodies rests, and not to the heat from without, as is the case with our own globe. In the early days of our earth's history, before the coming of life upon its surface, its air was doubtless beset by storms similar to those that sweep the spheres that still retain their ancient heat. But there is no reason to believe that for all the space of geologic time this atmosphere has ever been much more liable to these accidents than it is at present.

Science has already done a great deal to protect man from the dangers that come to him from the air. Lightning is now perfectly in his control; he can easily secure absolute safety in the times when it seems to rend heaven and earth. Can he hope by his arts to escape the bitterer ravage of the hurricane?

At first sight there seems little hope of any important contribution from science to this problem. There is, however, reason to believe that a careful study of the conditions which precede hurricanes may give us the data for determining the times when they may be expected to develop in any region. It is likely that by means of small balloons inflated by gas or heated air, with a conducting wire through the cord that retains them, it will be possible, by a well-known system, to determine the relative temperature of the air at different heights; so that if the hurricane be due to the difference of temperature at the earth's surface and in the upper regions of the air, a basis for prediction can be secured. This knowledge of the conditions which favor the production of hurricanes would be of little use in guarding against their destructive power, unless other means of protection were devised. It will doubtless be possible to build habitations that will be practically secure against their action, but for this purpose nothing but the most solid masonry will serve, — a class of construction for which we cannot look in the regions where most needed.

Even a cursory examination of the paths pursued by these storms shows that they tend to follow certain geographical lines, and that in any region where they have once occurred they are likely to happen again. If a careful study of hurricanes should show this certainly to be the case, it will be possible for those whose homes lie in the tracks of these meteors to take special means of insuring protection by building exceptionally strong dwellings or under-ground places of refuge in the time of such catastrophes. I am inclined to believe that the hurricanes of the Mississippi Valley tend to lose their intensity as the country becomes more generally tilled. As far as these storms depend on the heating of the earth's surface we should naturally expect some mitigation in their intensity from the tillage of the soil. As before remarked, the compact and exposed natural surface of the Western prairies, with little capacity for containing water, and of scant herbage, is more readily heated than a wooded or cultivated surface. As tillage becomes more general and the planting of timber more extensive, we may expect less disturbance in the atmosphere from the super-heating of the earth's surface in the long period of the strong sunshine, during the summer season in the Mississippi Valley. Yet we can hardly hope for a perfect immunity from these evils. The dweller on these open woodless plains has certain

advantages from the absence of forests; the earth is to his hand when he comes upon it; and with this advantage he must take the loss that comes from the want of the sheltering woods which exist in the older and better dwelling-places of his race. He can drive his plow easily and with swift profit; drought and hurricane serve but to balance the account with nature.

N. S. Shaler.

HYMNS AND HYMN-TINKERS.

"MANY gentlemen have done my brother and me (though without naming us) the honor to reprint many of our hymns. Now, they are perfectly welcome so to do, provided they print them just as they are; but I desire they would not attempt to mend them, for they really are not able. None of them is able to mend either the sense or the verse. Therefore, I must beg of them one of these two favors: either to let them stand just as they are, to take them for better for worse; or to add the true reading in the margin, or at the bottom of the page, that we may no longer be accountable either for the nonsense or for the doggerel of other men." So wrote John Wesley something over a hundred years ago in the preface to A Collection of Hymns for the Use of the People called Methodists. The outburst is both amusing, as showing the decided opinion the Rev. John Wesley, M. A., held in regard to the merits of his own and his brother's work, and instructive, as indicating the extent to which the practice of hymn-mending had been indulged in, even at that day. It has had but little effect, however, as a restraint upon the tinkering tendencies of succeeding compilers. There is hardly a stone in all the noble temple of our English hymnology which has not been chipped or beplastered, sometimes quite out of its original form and color, by these literary deformers. In a few cases they have done really good service, removing ugly projections or filling up unsightly crannies left by the carelessness of the original artist, but as a rule their work has been fearfully and wonderfully bad.

Looked at from the literary point of view, it is as disfiguring as are the names of John Brown and Ezekiel Spriggins cut into the cap-stone of the pyramid of Cheops. Seen from the moral side, it is hard to understand how these emendators defend their work from the charge of absolute dishonesty. Forgery is an ugly word, but there is no other which applies. The attempt to eliminate from Paradise Lost all references to hell, in order to make that poem edifying to such as disbelieve in eternal burnings, would probably be received with little favor, even if honestly undertaken. The words which people of good taste would use in reference to the man who should make it would be either very severe or very contemptuous. Yet the hymn-book compilers, of every denomination, have unhesitatingly and freely remodeled the hymns written by members of other sects, in order to adapt their phraseology to the creeds of the churches in which they were to be used. It is fair to suppose that such divines as Watts, Doddridge, Newton, and the Wesleys had certain well-considered opinions upon the subjects of which they wrote. It is not fair, nor is it honest, that their carefully chosen words should be so transposed or changed as quite to reverse the original sense. Nevertheless, this is frequently done, so that the singer, ac-