the long, flat shore, that the right combination occurs. For, when there is a ground swell on, the waves do not roll in continuously, but come in groups, and therefore we require the coincidence of the higher waves and the right minute on the shore.

Now, Morecambe Bay has a long flat shore, over which the tide comes in so fast that it has been known to overtake a coach-and-four. It is open to the south-west wind and the Irish Channel tide. The time when the "Barisál guns" are heard is when the great tidal wave is rushing up the estuaries in the Bay of Bengal. This is a very suggestive coincidence.

Before we go further in our investigation of air-thuds, it would be of great help if we would get some exact data as to the distance at which the sound of great guns, of blasting, or of waves, can be proved to have been heard. So far I have endeavoured to explain such sounds by surface action. I believe, however, so strongly in the rapidity and constant recurrence of earth-movements which must produce sound, that I would add a few words upon that point.

To begin with small sounds. When the sun is setting and the shadows of the mountain climb up the screes or talus, each part rapidly passes from sunshine into shade, and often into very cold shade. In such circumstances it is not uncommon to hear a crepitation among the fragments. This is quite in accord with the view that the downward travel of the screes is largely due to diurnal changes of temperature affecting the fragments of which they are composed. More rarely bangs are heard among the crags in similar circumstances. The ticking of the firedogs and iron-work of a grate when the fire has gone out, and the sudden and terrifying crack of the oak-wainscoted room, are familiar examples of the same kind of thing. In frost, of course, such noisy ruptures are common.

Now as joints in rocks are surface phenomena, due to shrinkage, detonations accompanying such disruptions should be often heard. Under the artificially-produced conditions of mining they are frequently heard. In the limestone quarry, from which the black marble of Dent is procured, the workmen found that, when they were quarrying the lower beds, and struck the rock with a pick or bar, fragments flew up into the air with a greater force than could be due to the blow of the pick, and in an unexpected direction. Also, when the tunnel was being made above Ribbles Head, and the workmen were engaged upon the bed of rock which formed the floor of the tunnel, pieces used to burst off with a loud noise, so that some of them thought that they had discovered a detonating shale. The explanation in both cases was that the hard thin bed which shelled off in that unexpected manner, rested on compressible shale, which, behaving as a fluid, transmitted the pressure due to the sides of the quarry or the wall of the tunnel, squeezed up the floor where the rock had been removed, and produced what in a coal mine would be called a "creep." The thin bed of hard rock above the shale rose in a slight arch over the upthrust shale, and was thrown into a state of tension, so that, when it was struck, chips, flakes, and sometimes larger pieces, would fly off. Phillips pointed out that "the removal of one side of a vein would leave the remaining side in a condition of strain resembling that of a strung bow, with a tendency to bulge outward into the workings," and it is known that from such a surface, especially when covered with a coating of crystalline vein-stuff, fragments fly off with cracks and explosions of various degrees of intensity. Earth-movements and the action of subterranean waters are continually opening out channels in which all these processes which produce strained surfaces and consequent explosions are going on. The widespread belief that fairy or goblin miners are heard working deep in the bowels of the earth probably arises from these natural rock-burstings, which are, from the nature of the case, more apt to occur along the line of lodes. I have myself been advised to go in for certain mining speculations because the sound of workmen's tools had been heard beneath the ground.

As on a small scale along lines of tension, artificially or naturally produced, so on a large scale along the lines of strain due to the great earth-movements, which are continually going on, analogous disruptions must repeatedly occur. When it is on a great scale, and the tremors and throws accompanying it have been observed, it is called an earthquake; when the noise only of the break is heard, it is unrecorded, because of the difficulty of distinguishing one air-thud from another. It must be a phenomenon of not uncommon occurrence along the lines of more rapid earth-movement, for we must bear in mind in all

such inquiries that time is an element in the bending of rocks. In the cases I mentioned above, it is the rapidity of the action due to the artificial removal of the mass that causes the rock to break rather than to sag or bend, and retain its curved form. This last we see commonly among the contorted strata where nature has applied the pressure more gradually; but we also see evidence of more sudden movement in faults and slickensides and similar phenomena, all of which are going on still, and must be accompanied by sounds could we only detect them.

T. McKENNY HUGHES.

Cactaceæ in the Galapagos Islands.

IN my notice (NATURE, p. 623) of Dr. Baur's botanical collections from the Galapagos Islands, I intended to add a few words respecting the Cactaceæ, but forgot it at the last moment. This natural order of plants forms the most conspicuous feature in the vegetation of some of the islands, as may be seen in the excellent views illustrating the cruise of the U.S. ship *Albatross*; yet Darwin, so far as I can discover, is the only naturalist who ever brought away any specimens, or contributed to any more exact knowledge than can be got from photographs on a very small scale. The presence and abundance of Cactaceæ in these islands is highly interesting, especially in relation to the age and origin of the flora, and to the fact that none exist in Juan Fernandez, though they abound in Chili. They are also of great importance to the animal kingdom during long droughts, as they are then the only source of water. As we learn from Darwin, the succulent branches are eagerly devoured by the large tortoises, lizards, and various other animals. He found that lizards four feet in length were easily enticed whenever he threw them a piece of a branch, and small birds would come within a few feet of him and peck at one end whilst a lizard was eating at the other.¹ Darwin also regarded the Cactaceæ as a source of food; and it is noteworthy that animals were mainly dependent on the branches broken off by wind. *Opuntia galapageia* was found by Darwin on James's Island, growing from six to ten feet high, with a trunk a foot in diameter, and so densely covered with strong spines as to be protected from destruction by predatory animals. The younger branches being only long elastic bristles. Dr. N. J. Andersson, a Swedish botanist, who visited the islands in 1851, states (Eugenies Resa, "Botanik," p. 95) that this cactus grows in all the islands, and he adds that he observed at least four or five other species, but had not time to collect specimens or to sketch them. In another place ("Linnaea," xxxi., 1861-2, pp. 571-631) he particularly mentions the *Opuntia* growing in lava where nothing else would grow, forming huge candelabra-like objects with pretty red, shining fruits. It is evident, too, from the photographic views reproduced in the "General Sketch of the Expedition of the *Albatross*," that one (or more) species of *Cereus* attains a height of ten or twelve feet, and is equally prominent in the landscape. Perhaps the next botanist who visits the islands may find time to study the Cactaceæ. But when will any Government think it of sufficient importance to attach a really qualified botanist to such expeditions? I ought to add that Dr. Baur is not a botanist, but he appears to have done his best as a botanical collector.

W. BOTTING HEMSLEY.

Slow Lightning.

AS far as I know, the first description of slow lightning occurs in your issue of November 7. It must be very rare, for I have never met any one who would readily believe in its existence. I write to testify to the accuracy of Mr. Crawford's description, though I have not seen it quite as slow as the flash which he timed. The best example that I ever saw was in a storm over London some eighteen years ago. A thick stream poured down, in the sort of curve which liquid takes from a kettle, and was then slowly joined by a similar stream from the opposite direction, the united stream then continuing its slow course downwards. I was not where I could see the end of it. The peculiarities—the breadth of the streams, and their deliberate motion—could scarcely be an optical delusion. The streams did not appear to me as "chains."

I have observed lightning all my life, and since it has begun to be photographed, I have been looking out for pictures of the various types. I hope we may get some picture of this, and

¹ See *Magazine of Zoology and Botany*, i. (1837), p. 467, where Prof. Henslow describes and figures *Opuntia galapageia*.