LETTERS TO THE EDITOR.

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The Great Submergence.

THE glaciation of the hills and glens all over the west of Argyllshire present phenomena which have for many years convinced me that the chief glaciating agent cannot possibly have been what is called an "ice-sheet." Ordinary glaciers, descending from the hills, have probably been concerned more or less. But the main agency has been, in my opinion, heavy "floe," or floating ice, driven by tides and currents during a submergence and a re-emergence of the land to the extent of at least 1500 feet. The main objection to this view has always been the absence of marine deposits, and especially of marine organisms. It is true that we have very few remaining beds of gravel or sand, and in those, as yet, no mollusca have been discovered. But I have never thought this objection a very strong one, because the submergence may not have been under conditions favourable to molluscan life, and dead shells, carried where they never lived, may easily have long ago been dissolved out. Quite recently, however, shells in great variety have been found at high elevations in Ayrshire, by Mr. Smith, of Kilmarnock. Moreover, these are embedded in the true boulder clay. And where these are wanting, marine microzoa have been detected in abundance by the most skilled and distinguished microscopist of the day. Stimulated by these discoveries, I have lately made a closer search for any remains of loose sands or gravels among our hills. That search has been rewarded by finding a well-marked fragment of an elevated sea-beach at the height of 350 feet above the sea, and in this deposit foraminifera have been found in fair abundance. Another place, quite 500 feet above the sea, has yielded similar evidence; and I have now very little doubt that such evidence will accumulate as the result of further search. This, however, is enough to prove a very recent submergence to a depth which would profoundly alter the distribution of sea and land along all our shores, and would divide the county of Argyll into a group of islands. No reasonable limit can be placed to the possible depth of this submergence. I have no theory as to the causes of it. But it may quite as well have been 1500 as 500 feet; and we must yield to any clear evidence of effects which cannot otherwise be explained. I need not say that the evidence, which in the latest years of his life carried conviction to the mind of the late Sir Joseph Prestwich, that there has been very lately in geological history a great submergence, which was comparatively sudden and comparatively transient, is evidence which no geologist can put aside without the fullest and most candid investigation. ARGYLL.

The Visibility of a Sound Shadow.

Two months ago I received the following letter from Mr. E. J. Ryves.

"On Tuesday, April 6, I had occasion, while carrying out some experiments with explosives, to detonate 100 lbs. of a nitro-compound. The explosive was placed on the ground in the centre of a slight depression, and, in order to view the effect, I stationed myself at a distance of about 300 yards on the side of a neighbouring hill. The detonation was complete, and a hole was made in the ground 5 feet deep and 7 feet in diameter. A most interesting observation was made during the experiment.

"The sun was shining brightly, and at the moment of detonation the shadow of the sound wave was most distinctly seen leaving the area of disturbance. I heard the explosion as the shadow passed me, and I could follow it distinctly in its course down the valley for at least half a mile: it was so plainly visible, that I believe it would have photographed well with a suitable shutter."

On receiving this note, I asked and obtained permission from Mr. Maxim to be present if a further experiment of the kind were contemplated. I designed and had prepared a special shutter which, on the breakage of an electrical circuit, would in the 40th second make an exposure of about 1/300 second. Unfortunately the battery that I brought with me proved insufficient, so that I had to discard this, and use an ordinary

Thornton-Pickard shutter actuated by hand. Neither the exact moment nor duration of the exposure were under such perfect control, and, as events proved, I could not get the exposure until the shadow had passed me. I had, however, fortunately asked Mr. Paul if he would be so good as to take a picture of the explosion with his animatograph. Mr. Hunt, his manager, came himself, and secured a good series.

Returning now to the eye observation: Mr. Ryves informed me he saw the expanding shadow on an intermediate occasion when only about 10 lbs. were detonated. On the day on which I was present (May 19), about 120 lbs. of nitro-compound were detonated, and 10 lbs. of black powder was added to make sufficient smoke to show on the plate. As the growth of the smoke cloud is far less rapid than the expansion of the sound shadow, no confusion could result from this.

At the time of the explosion my whole attention was concentrated upon the camera, and for the moment I had forgotten to look for the "Ryves ring," as I think it might be called; but it was so conspicuous that it forced itself upon my attention. I felt rather than heard the explosion at the moment that it passed. We stationed ourselves as near as prudence would allow at a distance of 120 yards, so that only about one-third of a second elapsed between the detonation and the passage of the shadow; but the precision of observation of coincidence when very rapid movement occurs is so great, that I am quite satisfied that the observation was correct. The actual appearance of the ring was that of a strong black circular line, opening out with terrific speed from the point of explosion as a centre. It is impossible to judge of the thickness of the black shadow; it may have been 3 feet, or it may have been more at first, and have gradually become less in thickness or, possibly, in depth of shade.

I have some difficulty in understanding why the whole ring should be visible if the phenomenon is the same as that which Prof. Mach and I have photographed. In our cases a bullet travelling at a speed greater than that of sound, forms a hyperboloidal shell of compressed air round about it. Light waves passing nearly tangentially, but just entering the shell, are refracted inwards, and thus leave a black line when they fail to strike the photographic plate. As they strike the plate within this black line on a part to which other rays have come nearly direct, an extra bright line is formed within the dark one. That which is essential, however, for the formation of the dark line is the tangency of the incident light.

Now, in the case of a hemispherical explosive wave it is clear that the sunlight can only be tangential over a semicircle, and that the shadow of such a wave should be a semi-ellipse, the eccentricity of which would depend upon the altitude of the sun. There could be no true tangential shadow on the sunward side of the explosion. Observation, however, showed a complete ring. If, as has been suggested to me as possible, the explosive wave does not travel at equal speeds in all directions, but is retarded near the ground, the wave front near the ground might be sufficiently inclined for the sun's rays to be tangential over much more than a semicircle. On May 19, when I made the observation, the sun had an altitude of about 58°, but on April 6, when Mr. Ryves made his first observation, the altitude was only 45°.

Mr. Maxim, with his usual ingenuity, suggested that perhaps what was observed was not a sound shadow at all, but merely a progressive bending down of every blade of grass as the explosive wave passed by. This would no doubt occur, and might be visible, but it is difficult to see how so black a ring should be produced in this way.

The animatograph fails to show any black ring; and this is not surprising, as with the exposure of about 1/100 second the shadow would have to be at least 11 feet thick, in order that some part should remain obscured during the whole exposure. If the black line is just without an equal bright line, as in the bullet photographs, and both are taken in by an exposure, it is hardly to be expected that any definite result should be obtained. As a fact, there is clearly seen a circular light shading, which does—so far as one can judge from the supposed rate of working, and the known distances—expand at about the same rate as the observed shadow, but it is lighter than the ground and shaded, instead of being dark and sharp, as seen by the eye.

I feel that the imperfect account which I am able to give is of sufficient interest to appear in the columns of NATURE, but I hope that it may induce those who have occasion to detonate heavy charges to make any observations that opportunity allows.