

Here again was an increase, and one which legume tubercles could not be brought in to explain. It was only when Lawes and Gilbert, trying to get chemical evidence, grew feeble, unnatural plants under unnatural conditions that they failed to get a similar increase of nitrogen. On this ground alone they supported the theory of the inability of the plant to draw nitrogen from air, and thus supported themselves in the notorious controversy with Liebig, the distinguished German who has done more for agriculture than any other man of science, and who, by the way, denounced the Rothamsted experiments in no measured terms (see the "Natural Laws of Husbandry," pp. 157 and 298).

Obviously, therefore, to show that plants fix free nitrogen is to undermine the work with which Rothamsted is chiefly identified.

Your readers will understand the value of the critique when they know that the initials under it are those of the director at Rothamsted.

THOS. JAMIESON.

Glasterberry, Milltimber, April 10.

I AM glad to see that Mr. Jamieson does recognise the necessity of some proof of his assertion that nitrogen has been fixed by the plants he has been examining; he now says that "it may now be forthcoming." When Mr. Jamieson's "may" has been converted into "is," chemists and botanists may begin to consider his speculations as to how the process is effected. For let us bear clearly in mind that Mr. Jamieson's theories only deal with the question of *how* the nitrogen is fixed; that it is fixed at all he takes for granted.

But what an unlucky series of experiments to enforce his argument has Mr. Jamieson selected from Rothamsted. He quotes three non-leguminous crops, wheat, barley, and roots, which when grown continuously on the same land for a period of twenty-four to thirty years have removed on the average 16 lb. to 22 lb. of nitrogen per acre per annum. But at the beginning of the experiments the soil was estimated to contain about 3000 lb. per acre of combined nitrogen, *i.e.* five times as much as the thirty years' cropping has removed. Furthermore, analyses have been made and published which show that the soil has lost nitrogen during this period; the average loss on the unmanured wheat plot from 1865 to 1893 was 10 lb. per acre, which if added to the 5 lb. per acre of combined nitrogen brought down by the rain pretty well accounts for the 19 lb. per acre removed in the crop. Knowing as we do that there are great reserves of nitrogen in the soil, and that they slowly become available for the plant, there is no reason to suspect that these non-leguminous plants have needed to take any nitrogen from the air to yield the crops that are recorded.

Then Mr. Jamieson quotes the output of nitrogen from two leguminous crops, clover and beans, and it is just about double that of the non-leguminous crops; very much more than double, in fact, if calculated on the number of crops actually obtained, and not spread over an average of years. Yet Mr. Jamieson goes on to say that the "legume tubercles" cannot be brought in to explain this; when the only crops yielding anything like an average amount of nitrogen are the two, beans and clover, which by accepted theories obtain nitrogen from the air by means of the bacteria in the "tubercles" on their roots. Most people regard these experiments as a very sound piece of evidence for the fixation of nitrogen by leguminous crops alone.

Let us consider these results from another point of view: the wheat crop without nitrogen, but with phosphoric acid and potash, at Rothamsted averages about fifteen bushels per acre, barley about twenty bushels per acre, the root-crops (mangels) about 5.4 tons per acre: this is the sort of level that is reached when the crop has to rely upon the air and the original stock of nitrogen in the soil. Is Mr. Jamieson proposing to recommend farmers to grow crops of this size, for that is what they must come to when they have only the air to draw upon for their nitrogenous food?

In his concluding paragraph Mr. Jamieson appears to suggest that Lawes and Gilbert ran the Rothamsted ex-

periments as a sort of conspiracy to disguise the truth in favour of a prepossession of their own, and that after their death the body of scientific men who constitute the committee of management engaged their present director to continue the traditional fraud; this is a "theory" which, like others of Mr. Jamieson's, must require a robust confidence in the credulity of his disciples.

A. D. H.

A Horizontal Rainbow.

I SHALL be much obliged if a reader of NATURE will kindly give me an explanation of the following:—

I was on Loch Lomond yesterday, a perfectly still, cloudless day, with haze as from east wind over the mountains. There had been hoar-frost in the morning. About 10.15, from the deck on the steamer at Balloch, I observed a broad patch of strong prismatic colours on the absolutely calm surface of the loch about half a mile from the pier, my back being turned to the sun. I watched this patch with interest, and, as the steamer approached it, it gradually lessened and almost disappeared; but in its place a rainbow, faint but distinct, lay horizontally on the surface of the water, one end resting beside the bow of the steamer and the arc curving for perhaps 150 yards ahead, the sun still being behind me. I never saw anything of this kind before, and was much interested. The loch was absolutely calm, reflections of sea-gulls, &c., being perfect.

The only explanation I can think of is that, after the hoar-frost and possible sea-fog of the earlier morning, there was just a film of fog left undisturbed on the calm surface of the water, sufficient to break up the rays of the sun into their component parts.

W. R. M. CHURCH.

Western Club, Glasgow, April 12.

THE SAN FRANCISCO EARTHQUAKE OF APRIL 18.

IN the immediate presence of a great catastrophe, in which hundreds of lives have been lost, and San Francisco, the "Queen of the Pacific," has been almost entirely destroyed, it is not to be expected that details of much scientific value should be recorded. All that is here possible is to describe briefly the course of events, to trace in rough outline their connection with former shocks and with the geological history of the district, and to refer to the unfelt earth-waves registered at distant observatories.

NATURE AND EFFECTS OF THE EARTHQUAKE.

Though the coast of California from San Francisco to Los Angeles is one of the chief seismic regions of the globe, the first and greatest shock was heralded by no warning tremors or earth-sounds. It occurred at 5.13 a.m. (that is, 1.13 p.m. Greenwich mean time), perhaps, as the seismographic evidence would imply, a few minutes earlier. As in all tectonic earthquakes of the first magnitude, the duration of the shock was considerable, not less than two or three minutes, and it was in this time that the chief part of the destruction, so far as it was directly due to the earthquake, was accomplished. Five minutes later another and less violent shock was felt, and, in the midst of almost continuous tremors, a third prominent shock took place at 8.15 a.m., and others shortly before 10 a.m., and about 1.30 and 7 p.m. None of these seems to have been registered in European observatories, but they sufficed to throw down walls already damaged. Soon after the first shock fires broke out in several parts of the city, and spread rapidly, the water-mains having been injured. Attempts, on the whole successful, were made to limit their extension by blowing up passages through the crowded parts, with the result that about one-quarter of the city may be ultimately saved.

Like Charleston, which was so seriously damaged by an earthquake twenty years ago, San Francisco is