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 experiments 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

built upon a peninsula; and the effects of the two shocks, as revealed by the distribution of the damage, were very similar. Although the whole of both cities suffered severely, the chief destruction was confined to houses built on low-lying "made" land. In San Francisco this land is occupied by business houses and warehouses, and, in the southern part, by cheap tenements and poorly-built lodging-houses. At 5 a.m. most persons were in bed, and thus there was little loss of life in the business district, and much in that covered by the tenements. The better-class residential district, situated on the hills, escaped with comparative impunity, so far as the earthquakes were concerned, though the fires afterwards spread to that quarter.

That San Francisco was situated within or close to the epicentral area is shown by the continuous after-shocks, and by the effects of the shock. Observers in the open air state that the streets could be seen to bulge and wave as if about to crack open. Three miles of railway have sunk out of sight between Suisan and Benetia; several railway tracks have been destroyed for scores of miles; and on the harbour-front the earth appears to have sunk from six to eight inches. Great cracks were formed in the streets, and these cracks were twisted into all shapes. The houses, before they were destroyed by fire, were also seen to be out of alignment.

Outside San Francisco many towns are known to have suffered severely, especially San José, Santa Cruz and Santa Rosa; others less seriously, from Mendocino on the north to Monterey on the south. With our present information (and the absence of news from neighbouring places, and especially from the Lick Observatory, is disquieting), the meizoseismal area is a band extending along the coast and parallel to the Coast Range, about three hundred miles in length and not more than fifty miles in width. The extent of the disturbed area will remain unknown until inquiries have been made, but it is curious how few details on the subject have yet been published. Los Angeles (only 350 miles S.E. of San Francisco) does not seem to have been affected to any extent by the principal earthquake, though the shock was felt severely throughout the whole of the neighbouring State of Nevada, and there are vague reports of more distant observations.

Position of the Epicentre and Seismic Sea-Waves.

If the line drawn so as to bound the known area of destruction be even approximately correct, there can be no doubt that the epicentre was submarine and situated some little distance from the coast. The fact that the shock was felt at San Francisco two or three minutes after the epicentral time implied by the seismic records is also in favour of this conclusion. The chief difficulty in accepting it lies in the absence of any very great sea-waves. Much of San Francisco is only about twelve feet above high-water mark, and would have been submerged by any considerable wave. There seems, however, to have been some disturbance of the sea. Many vessels, it is said, were washed ashore with each disturbance, and washed out again by the receding waters. There are also unconfirmed reports that Terminal Island, a seaside resort about twenty miles from San Francisco, has been destroyed by a sea-wave, and that other places on the Californian coast have also been swept away. At present it is probable that the first decisive evidence of sea-waves, if any existed, will come to us from the eastern shores of Japan, which would be reached by them in about ten and a half hours after the earthquake.

Geological Relations of the Earthquake.

The earthquakes of California have been studied for some years by Messrs. Holden and Perrine, of the Lick Observatory, and the geology of the State is being revealed through the labours of Messrs. Russell, Diller and Lawson; while an admirable summary of their relations was recently presented in M. de Montessus' valuable work on "Géographie séismologique" (pp. 404–412). Between the Rocky Mountains and the Pacific are the parallel chains of the Sierra Nevada and the Coast Range. Among the Rocky Mountains earthquakes are few and slight; on the eastern slopes of the Sierra Nevada they are more frequent, and sometimes, as in the Owen's Valley earthquake of 1872, of considerable severity. The western portion of the Sierra Nevada, the Cascade Range, is remarkably free from earthquakes, though it is worth noting by those who see an intimate relation between volcanic and seismic actions that it contains the recently extinct cones of Shasta, Mount Hood and Mount Rainier. Again, the Coast Range, and especially the districts surrounding San Francisco and Los Angeles, is one of the great seismic regions of the globe. Lastly, to the west of California the sea-bed deepens rapidly, the contour of 4000 metres lying only a short distance from the land, and from this region many of the strong Californian earthquakes are known to proceed.

Recent studies have established a close connection between these earthquakes and the geological structure of the district. Whether the earthquakes take place under the Coast Range or beneath the adjoining ocean, the longer axes of the isoseismal lines are either parallel or perpendicular to the sub-oceanic contour-lines, the crust-folds of the Coast Range and the long lines of fault of the Pacific sea-board. It is difficult to resist the conclusion that in the western United States we are presented with mountains in four successive stages of growth. In the Rockies we have ranges so ancient that they have almost ceased to grow; in the Sierra Nevada to the west another which is approaching old age; the Coast Ranges are in the stage of youthful, vigorous growth, with the possibility of a long and active life before them; while, still farther to the west and not yet risen above the ocean, there seems to lie an embryonic range, of which the San Francisco and other earthquakes are the birth-throes.

The Unfelt Earth-Waves.

In all parts of the world delicate seismographs soon afterwards recorded the occurrence of a violent earthquake. The first waves reached Victoria (B.C.) at 1.16 p.m.; at Washington the movement was so strong that the pen passed off the recording sheet. In a quarter of an hour the seismographs of Great Britain took up the tale, large disturbances being recorded at Shide, Bidston, and Edinburgh; at Birmingham the pointer of the Omori horizontal pendulum swept three times off the drum. Passing over to the Continent, they set to work the instruments at Berlin, Heidelberg, Vienna, Laibach, Turin, Rome, and many other places. The pendulums at Florence shared the fate of those at Washington and Birmingham. The seismograph at Cape Town also registered the movement, while those in Japan were disturbed by the waves proceeding in the opposite direction across the Pacific. Only the scantiest details are as yet made known, but, if we may judge from the diagram at Birmingham, the complete series of records will be one of great interest and value.

The first series of preliminary tremors reached Birmingham at 1h. 25m. 3s. p.m. (G.M.T.); they were

small in amplitude and had an average period of 6·4 seconds. At 1h. 35m. 7s. they were followed by the second series of preliminary tremors, much larger in amplitude and with an average period of 11·4 seconds. These tremors, as is now well known, traverse the body of the earth with velocities of about 10 or 11 and 5 km. per second respectively. At 1h. 45m. 13s. began the principal portion of the movement, consisting of undulations which travel over the surface with a nearly uniform velocity of 3·3 or 3·4 km. per second. In the initial phase of this portion the undulations had an average period of 44·1 seconds; in the slow-period phase (which began at 1h. 50m. 22s.) of 25·2 seconds, and in the succeeding quick-period phase of 16.2 seconds. Unfortunately, this portion of the record is incomplete, for the pointer of the pendulum swept off and on the drum three times, several waves being thus lost, and the initial epoch of the quick-period phase cannot be determined. The end-portion of the disturbance began at 2h. 1m. 4s., and consisted of a long series of unusually clear and regular waves with an average period of 15.0 seconds. The duration of this portion is uncertain, for these waves were reinforced at 3h. 28m. 38s. by the undulations of the principal portion which travelled through the antipodes along the major arc joining San Francisco and Birmingham. At 3h. 56m. 57s., however, the trace becomes nearly steady, but a careful examination reveals another series of long, low undulations from 4h. 58m. 32s. to 5h. 6m. 34s., which represent the return of the first series of surface-undulations after they had completed the tour of the globe and travelled once more as far as Birmingham. The interval between the first and third passages of these waves is 3h. 13m. 19s., and corresponds to a mean velocity of 3·36 km. per second.

MAGNITUDE OF THE SAN FRANCISCO EARTHQUAKE.

The mere fact that the earth-waves should disturb a seismograph after travelling 30,000 miles is sufficient evidence to show that the earthquake belongs to the very front rank. If we might estimate the intensity of a shock by the maximum range of movement at Birmingham, we should have to regard the San Francisco earthquake as much stronger than the Indian earthquake of April 4, 1905, but as inferior to the remarkable Central Asian earthquakes of July 9 and 23, 1905. The period of the larger waves approaches, however, so closely to that of the pendulums themselves that it by no means follows that the range and epoch of the maximum displacement of the instruments correspond with those of the earth's crust. Nor can we infer much from the extent of the destruction of the lofty, badly-founded houses of San Francisco. If the Colchester earthquake of 1884 had originated beneath the city and west-end of London instead of beneath the villages of Peldon and Rowhedge in Essex, the damage would have been considerable, and the earthquake would have held a higher place in our estimation. When, however, we consider the great area covered by the injured towns in California, the displacement of the superficial soil, the crumpling of the railway tracks, and the widespread registration of the unfelt waves, it is clear that we must give to the San Francisco earthquake a place inferior, no doubt, to the Lisbon earthquake of 1755 and the Indian earthquake of 1897, but probably one in the same rank as the Neapolitan earthquake of 1857, the Japanese earthquake of 1891, and the Indian earthquake of 1905.

C. DAVISON.

THE LIFE OF THE AUSTRALIAN BLACKS.[1]

BOTH for the anthropologist, who wants well-sifted and trustworthy material, and for the ordinary reader who would like to know something about the life of the native Australian, this is a most useful book. In fact, for the latter purpose it may be said to stand entirely alone. There is no other work on the Australians which gives anything like so good a general view; it is clear of superfluous technicalities, eminently readable, and written with so much sympathy that we cease to be surprised at the success of the writer in getting at such secret matters as male initiation ceremonies and beliefs about Byamee, all of which are strictly forbidden lore to the Euahlayi woman. Mr. Lang's introduction explains the bearing of the book on current controversies.

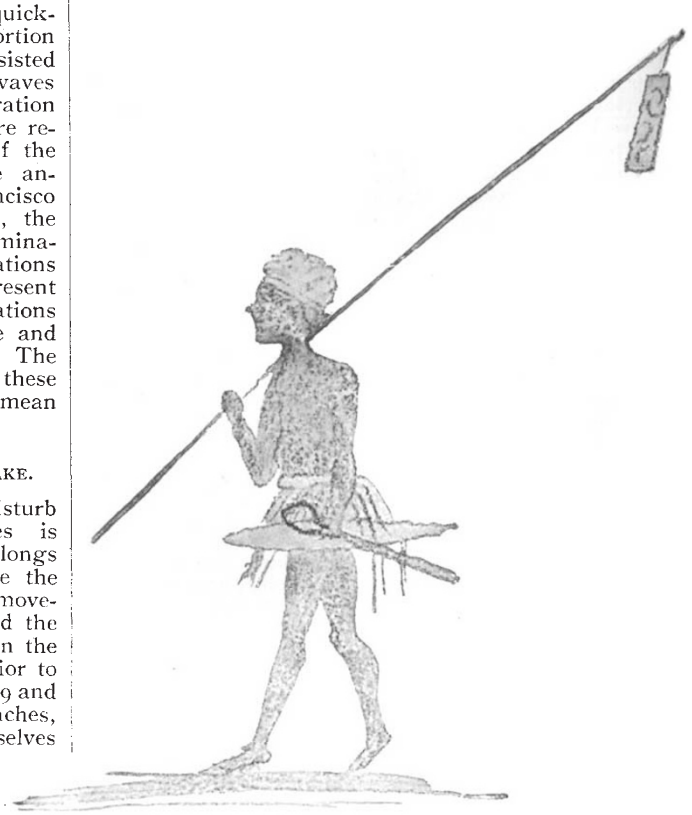

FIG. 1.—A native carrying a message-stick. From "The Euahlayi Tribe."

Besides these two important subjects, Mrs. Parker has much to tell us about the social organisation, magicians and their initiation, a witch woman whose feats are distinctly mystifying, the life of children of both sexes up to and including the initiation ceremonies, burial customs, dress, amusements, the provision of food, and mythology; and on many points we learn something which throws light on previous knowledge. Although we hear nothing of the so-called sex-totem among the Euahlayi, they hold that the male children are made by a lizard, the female by the moon, who is sometimes assisted by the crow. This looks like the raw material of the sex-totem. It

[1] "The Euahlayi Tribe, a Study of Aboriginal Life in Australia." By K. Langloh Parker; with an Introduction by Andrew Lang. Pp. xxvii+156; with 6 illustrations by a native artist. (London: A. Constable and Co., Ltd., 1905.) Price 7*s.* 6*d.* net.