ance of the family. Now the *Durga Pujah* and its equivalent ceremony in Upper India occur in October, *i.e.* at the beginning of the healthy season with abundant food-supplies. This is one more instance of the perfect adaptation of the Hindu religious calendar to the natural changes of the seasons.

Allahabad, September 9. S. A. HILL.

A Shell-Collector's Difficulty.

CAN any of your readers help me in the following case? I am a shell-collector, and my minute and delicate species (*Diplommatina* and such like) are kept in glass tubes. I have lately observed that some of the tubes in the cabinets were becoming opaque; a milky efflorescence seemed clouding the *inside surface*. I found the same thing in a box containing about 100 that I had placed on one side. I then opened a box of 500 which had never been unpacked since they were received, some four years ago. *All* these are more or less affected! I then opened a third box, from another maker, and in this 500 I observed many beginning to be affected. What can be the reason? Each of these tubes is tightly corked, and I see the glass under the cork is *not affected*. I have tried various means to restore the clearness without avail. I have boiled some, and roasted some in the sun, steeped others in alcohol, oil, &c.; nothing seems to do any good. Can any of your scientific readers divine the cause, and suggest a remedy? E. L. LAYARD.

British Consulate, Noumea.

"Fauna and Flora of the Lesser Antilles."

IN the article on this subject in NATURE of August 16 (p. 371), it is stated that Guilding discovered a *Peripatus* in Dominica many years ago. This is, I believe, an error, for Guilding's *Peripatus juliformis* was found by him in St. Vincent, an island to the south of Dominica, and the first specimen of *Peripatus* found in this island was, I understand, the one now in the British Museum, taken home by Mr. G. Angas.

The rediscovery of the Dominica *Peripatus* is rather curious. In 1883-84, at the special request of Prof. Moseley, I searched for the animal in all likely places, but did not succeed in finding any specimens. At that time Prof. Moseley and I were not aware of Mr. Angas's discovery. I mentioned my non-success to Mr. Ramage, and asked him to look out for the interesting animal, and, strange to say, soon afterwards his boy brought him three specimens, but Mr. Ramage has not been able to obtain any more. I employed the same boy after Mr. Ramage had left Laudat, and he brought me two specimens, and said that he could find no more although he had searched for several days. These two I sent to Prof. Moseley at Oxford. A few weeks ago another specimen was brought to me from the windward (or eastern) side of the island by the same boy, who found it about 300 feet above the sea, not far from the coast. Laudat is on the leeward side, at an elevation of about 2000 feet above the sea, and on the margin of the virgin forest. The six specimens of the Dominica *Peripatus* recently found may not belong to a new species, but the rarity of the animal is interesting. Had it been common in any degree, Mr. Ramage and I must have found it, but neither of us has succeeded in doing so.

Mr. Ramage, who has been labouring with unflagging zeal, leaves to-day for St. Lucia, but he will return here later on in the year, so as to continue his botanical work. His specimens of the forest flora form, I believe, the most complete collection that has yet been made in the island, and his enthusiastic work deserves recognition. H. A. ALFORD NICHOLLS.

Dominica, West Indies, September 15.

Sun Columns.

WITH reference to the simultaneous appearance of five sun columns described by Mr. Brauner (August 30, p. 414), the following descriptions of three different manifestations of the phenomenon may perhaps be of interest.

April 19, 1887, 7.25 to 7.37 p.m., calm, sky clear except a smoky grayish haze low on the western horizon, behind which the sun had set. The solar rays concentrated into one perpendicular continuous beam of uniform diameter with the sun, and reaching to an altitude of about 20°. The beam sharply defined, and of a reddish tint strong enough to be detected behind the haze. Near the summit a few tinted strips of fine cloud forming an angle, and giving the whole the appearance, as described by the person who called my attention to it, of "a ship's mast and yards." No trace of side rays visible.

June 10, 1888, 8 to 8.25 p.m., sun set below horizon; to an altitude of about 10°, sky comparatively clear, only a little cirro-stratus; above this, to an altitude of 20°, the cirro-stratus much more dense, and in this part only was a sun column distinctly visible, terminating abruptly, and showing no trace in the cirro-cumulus above. In the lower 10° there was also no evidence of the column. It was at first of an old gold colour, then gradually changed to a deeper red by 8.15 p.m., when the clouds on both sides were suffused with the same tint, and by 8.27 it had disappeared.

These two cases I observed from my own residence; the third has been communicated to me by Mr. W. Manning, who was chief officer of the ship *Balmore* when he witnessed the phenomenon. Not having access to the ship's log, he could not give me the exact date and position, but it was some four or five years ago, "in about 25° or 30° S. lat., and from 120° to 130° W. long., during the first dog watch (4 to 6 p.m.), observed the sun at an altitude of about 25° of a dull red colour, with all its rays apparently drawn together and forming a pillar of light reaching from the sun down to the horizon, and about the sun's diameter in breadth." Mr. Manning told me that of all the curious sights he had seen at sea none had been so impressed on his mind as this sun pillar.

These are instances of continuous pillars from the sun upwards and downwards, one showing the half furthest from the sun only. HY. HARRIES.

Rosebank, Hounslow, September 28.

THE REPORT OF THE KRAKATAÕ COMMITTEE OF THE ROYAL SOCIETY.[1]

II.

AN appendix to Prof. Judd's section on the geological aspects of the eruption embraces a series of data collected by Dr. Meldrum, F.R.S., of Mauritius, regarding the falls of dust and the occurrence of masses of pumice throughout the Indian Ocean in 1883-84, which he had already communicated to the British Association in 1885. Mr. Scott's prefatory note thereon shows that while such data are of value in exhibiting the immense magnitude of the eruption they cannot help to throw much fresh light upon the question of the Indian superficial oceanic circulation, since the pumice was evidently affected almost as much by the motion of the air as by that of the water. Thus, while a comparison of the two maps reveals a general westerly drift in the direction of the well-known left-handed circulatory system of the Southern Indian Ocean, a detached phalanx of pumice masses off the north-west coast of Australia in 1884 (in the second map) shows, as Mr. Scott observes, a probable drift thither "before the north-west monsoon which would prevail in those seas from November 1883 to March 1884."

In one other point, however, apart from their general interest, these data are valuable in confirming the general westerly trend of all the ejecta at the time of the eruption—a fact whose significance becomes subsequently so marked when dealing with the spread of the optical phenomena.

In the plates of geological sections which are appended to this Part attention should be paid to (3) (4) (5) (6) of Plate 4, in which natural and artificial pumice and dust from Krakataõ are compared, since they have an important bearing on Prof. Judd's conclusions.

Part II. of the Report, which deals with the air waves and sounds caused by the principal eruption of Krakataõ on August 26 and 27, was prepared, under the direction of Lieut.-General Strachey, F.R.S., principally by Mr. R. H. Curtis, of the Meteorological Office.

The air-waves, as apart from actual sounds, were one of the most extraordinary features of this unique out-

[1] Continued from p. 542.

burst; for, while it is possible that similar waves were propagated through the atmosphere during great eruptions in former years, these appear to be the only instances recorded of anything of the kind on such a vast scale since the establishment of continuous self-recording barometers.

That air-waves caused by the sudden expansion of the erupting gases could leave a perceptible record on all the barometer traces as far as the antipodes of Krakatão, is of itself a sufficiently remarkable fact, but that such waves could record their passage back and forwards no less than seven times, is a circumstance which even now, five years after its occurrence, fills us with astonishment. A selection of forty-seven stations has been made, which, as far as possible, represent the habitable world; and the times of passage of the wave from Krakatão to the antipodes and from the latter back to Krakatão have been deduced by comparing the significant, and in many cases similarly-shaped, notches in the barometer traces.

Of course, where, as in the present case, the form of the wave itself was complicated, gradually became deformed, and was traceable for no less than 127 hours from its commencement, perfect accuracy in determining the precise moments of passage of the various phases could scarcely be expected. Yet it is evident on the face of it that a very high degree of accuracy has been attained, by which not only can the precise moment of the great outburst be determined by the simple process of calculating backwards, but also certain variations of velocity be traced in portions of the wave which took different routes over the globe.

The general pace at which the air-wave spread outwards in concentric circles from Krakatão as a centre, was 700 miles per hour, which is slightly less than the velocity of sound at zero Fahrenheit, viz. 723 miles. The entire circuit of the globe and back was thus made in about thirty-six hours. Also, by a careful comparison of times and probable errors, the probable moment of *the greatest explosion* is calculated to have been 2h. 56m. G.M.T., or 9h. 58m. local time, on the morning of August 27.[1]

This great explosion appears to have been not only the culminating point of the Krakatão eruption (the preceding minor outbursts appearing as a mere roughening of the barometer scale, or a series of moderate oscillations on that of the gasometer at Batavia), but owing to its surpassing intensity, a feature *altogether peculiar to this eruption*, and one by which it will always be distinguished from others, such as that of Asama (Japan) and Skaptar Jokull in 1783, or Tamboro in 1815, which, in respect of the amount of material ejected in the form of lava, and other effects, appear to have equalled if not exceeded it.

One of the most interesting results of this discussion of the Krakatão air-wave has been the discovery of its variation of speed according as it travelled *with* or *against* the earth's rotation. As a general fact it may be said that such variation is plainly traceable to the prevalent drift of the winds.

Thus in the extra-tropics the wave moving from west to east was accelerated, and that from east to west retarded, by about 14 *miles* per hour; while within the tropics the wave which passed through Mauritius and Loanda was affected in a precisely reverse manner, the passage eastwards being retarded, while that westwards was comparatively unaffected, the amount corresponding to an east to west wind of about 10 *miles* an hour. It is at least curious to notice, that on p. 35 of the "Motions of Solids and Fluids," by Prof. Ferrel (Washington, 1882), the value of the due E. to W. component of the trades between 15° N. and S. lat. is given as 10 *miles* per hour, while the mean of the W. to E. component of the anti-trades for latitude 45° at the earth's surface and a height of 3 miles above it, is exactly 14½ *miles* per hour.

[1] This differs by only 4 minutes from 10h. 2m., the epoch determined from fewer data by M. Verbeek.

The greatest general retardation took place in the Southern Ocean, possibly owing to the low temperature of the southern hemisphere in August. All these points are very distinctly shown in the diagrams.

As regards the actual sounds, the facts are without precedent. The unvarnished record reads like a fairy tale. When we are told that at distances of over 2000 miles from the volcano, the noise was like the firing of heavy guns, and that at numerous points of the Indian Ocean steamers were despatched in search of supposed vessels in distress, we are prepared to accept with less hestitation the numerous other collateral evidences of the enormous explosive energy which generated them.

The area over which the sounds were heard is roughly estimated at *one-thirteenth* of the entire surface of the globe. In other words, it was nearly equal to Europe and Africa together, or slightly exceeded that of both Americas. All these details are illustrated by numerous diagrams.

Part III., by Captain W. J. L. Wharton, R.N., F.R.S., deals with the so-called seismic sea waves generated during the eruption; one of which not only dealt death and destruction all over the Straits of Sunda, but travelled as far as Cape Horn, and possibly the English Channel.

It appears that there were two sorts of waves generated—one of long period (two hours), which alone recorded itself on the automatic gauges and travelled to great distances; and others of much shorter period, which were mostly confined to the immediate vicinity of the volcano.

The only hypothesis by which the facts can be reconciled, according to Captain Wharton, is that at the time of the greatest explosion, at 10 o'clock on August 27, "waves of both characters would be more or less synchronously formed," the longer wave being caused by upheaval, and the shorter ones, which caused the destructive effects in the Straits of Sunda, by the displacement due to ejected masses or fragments of the volcano falling into the sea all round it.

In proof of upheaval, which appears to be the only probable cause of the longer wave, Captain Wharton cites the generally shallowed condition of the sea immediately surrounding Krakatão, especially on the northern side.

We cannot, however, help observing that, according to Prof. Judd, the geological evidence is entirely against upheaval throughout the area; and the formation of the new shoals and islands is attributed by him *solely* to the piling up on the sea floor of the coarser matter, including the framework of the volcano, which was ejected during the explosive outbursts. It is a remarkable fact, indeed, that during the eruption there was no trace of any local seismic disturbance such as might be supposed to accompany an upheaval of the ground. A variety of peculiar effects were witnessed, such as clocks stopped, lamps broken, and houses cracked, but all of these were traceable to air and not earth vibrations.

The precise cause, therefore, of the long wave will, as Captain Wharton says, "ever remain to a great extent uncertain." One fact, however, remains clear—that both it and its minor predecessors were distinctly connected with corresponding explosions from the crater, which recorded themselves in unmistakable language on the gasometer pressure-gauge at Batavia. Whatever the precise proximate cause, therefore—whether slow upheaval, according to Captain Wharton, or the impact of falling matter, according to Prof. Judd—the action *commenced* with each explosion.

The height of the local manifestation of the great wave at 10 o'clock is estimated to have been 50 feet, though in places where it reached the shore it appears to have run up to 70 feet.

The terribly destructive effects of these shorter "super-seismic" waves, of which this one appears to have been the greatest, are amply detailed in M. Verbeek's Report, and the accompanying views of the localities visited. They reached the above majestic height only in the

immediate vicinity of the volcano, rapidly falling off in size at a comparatively short distance from the Sunda Straits.

The longer waves, with the original period of two hours, are traced by automatic and eye observations to have proceeded mainly in a westerly direction from Krakatão, being noticeable at Ceylon, all over the western part of the Indian Ocean, the south coasts of Africa and South America, the west coast of Australia, and possibly—though the evidence is not free from doubt—as far as the west coast of France and the entrance to the English Channel. In other directions, such as the China Sea, the Pacific, and the Gulf of Mexico, they do not seem to have been felt, the supposed indications not being compatible in any way with the times and distances.

As a general result, it may be said that the mean depths deduced by the formula $V = \sqrt{gh}$, from the best data for the speed of the waves, corresponded fairly with that given by the soundings, but in nearly every case the formula gave a smaller depth than the soundings. This and other circumstances lead us to conclude, not so much that the formula is incorrect, but that, with so few, and in some cases such badly placed, automatic gauges, and from such complex oscillations as seem to have occurred in many of those discussed in this section, it is scarcely possible to arrive at anything but a very rough approximation to the mean depths. The shelving of the bottom near land, which in many cases is not well determined, and the possible existence of ridges in mid-ocean, constitute obstacles to a determination of mean depth, which is all the passage of such waves can indicate. In so far, however, as they yield an approximate check of this kind on soundings, their observation ought to be encouraged by the establishment of more automatic gauges in suitable spots.

One very peculiar feature of the Krakatão long waves is that, while their original period when leaving Krakatão was two hours, they became subdivided (possibly by an interpolated series caused by reflection from the coast of Java) into waves of half this period ; and, by the time they reached the North Atlantic, into waves of about one-quarter of this period. Their consecutive oscillations could thus only be identified with those of the original oscillations by doubling or quadrupling the observed periods.

Although at great distances from Krakatão the height of the largest long wave was, as might be expected, only a few inches ; at such comparatively remote places through the more open route to the west as Ceylon and Mauritius, the higher and shorter waves made their presence felt to heights of several feet, and created considerable astonishment as well as damage in these localities.

Like the air and sound waves, the occurrence of seismic waves on such a scale and over such a wide area appears to have been quite unprecedented ; and their discussion, like that of the former, will in the present case probably yield results of considerable value to hydrography as well as other branches of science.

(To be continued.)

FOUNDATIONS OF CORAL REEFS.

THE following extract from a letter from Captain Aldrich, R.N., H.M. surveying-ship *Egeria*, now employed in the Pacific Ocean, is interesting from several points of view.

". . . . The following morning at daylight (July 10) we picked up 268 fathoms (volcanic rock) some considerable distance southward of the Pelorus Reef. This, again, will involve a further search. Twelves miles to the northward the depth was 444, and two subsequent soundings at five-mile intervals gave 713 (ooze) and 888 (ooze). From here the soundings continued to grow shoaler, until in lat. 22° 51′ S., long. 176° 26′ W., we sounded in 335 fathoms (cinder), being close to the assigned position of the Pelorus Reef. The water deepened again to 719 (cinder), when we hove to for the night. On July 11 we continued about this position, the shoalest sounding being 246. On the 12th we continued the search, and by following up at quarter-mile intervals struck 95 fathoms late in the afternoon. Prepared a beacon, and the following day (July 13), after excellent star observations, sounded and shoaled as yesterday, and when the men were standing by to slip the beacon, discoloured water was reported from the mast-head ; it was almost immediately seen from the deck, and by 9 a.m. the beacon was dropped in 24 fathoms, with a stretch of light-greenish water extending in a northerly and southerly direction for about half a mile. The whalers were lowered, and remained all day in this green water.

"Meantime more discoloured water was reported from aloft, and I sent Mr. Kiddle up with his glasses, and he verified the report ; so, leaving the boats on the Pelorus, I went with the ship, and, after going two miles, I made out the small streak from the poop. It had remained as steady as possible, and had every appearance of being a very small shoal. The ship was taken to within 100 yards of it, and the dingy lowered to get a sounding on it ; no bottom, however, could be got, so the ship was put in the middle of it and a sounding of 150 (no bottom) obtained. A bucket of this water was drawn and a bottle of it preserved, but I do not see anything in it to account for the light greenish colour, and it may be that the colouring matter may not lie actually on the surface ; the fact remains, that this small patch was sighted at very nearly three miles distance from aloft, and that even when within 100 yards of it I believed it to be shoal-water, and that a sounding of 150 (no bottom) was actually obtained in the middle of it. On our return to the Pelorus, I was not, therefore, much astonished when I found that no very shoal water had been got by the boats. The ship was anchored in 14 fathoms, not far from the beacon, and the wire machines put into the whalers, and a search on bearings from the standard compass and mast-head angles carried on during the afternoon and on the next day, July 14. Nothing less than 14, however, was got, and I am under the impression that nothing less is to be met with, as the bottoms are loose ashes and cinder ; so that, as in the case of the Graham Shoal, there may have been a shoal quite recently which does not exist now. I think that had there been anything dangerous about it we should have seen it, as anchoring in 14 fathoms mid-ocean caused many inquiring eyes to be cast around. . . . .

"Another curious thing about the greenish water is that I went over it all in the ship ; and the line between it and the dark water was most distinct. Moreover, the shoalest sounding of 14 fathoms was not found in the light water, but in the dark water alongside it. There was no sign of coral among the bottoms brought up. . . . My attention was pretty well occupied at this time, and it did not occur to me to do more than have a bucket of the water drawn from the green colour to preserve, which has been done. Afterwards, I much regretted that I did not get specimens from different depths, as certainly this is a most curious instance of, in one case, picking up a shoal from the existence of some colouring matter, not coral ; and, in the other, of being almost positive that a shoal existed where an actual sounding proved it not to do so. I can quite excuse a man reporting a shoal under such circumstances, and it may be that a good many of the reported dangers have come on the charts in this way. . ."

The position of the Pelorus Reef referred to is in lat. 23° S., long. 176° 25′ W., about forty miles south of Pylstaart Island, which is volcanic. The reef was originally reported in 1861 by H.M.S. *Pelorus*, Commodore Seymour (now Lord Alcester), the ship passing within one-third of a mile of it, when breakers were distinctly seen.