

THE BRITISH SOLAR ECLIPSE  
EXPEDITION.<sup>1</sup>

Aboard H.M.S. "Encounter."

April 12, 1911.

MY last letter was concluded when the Tonga Islands came in sight, for I knew that as soon as we dropped anchor my time would be fully occupied. We have now been here ten days, so there is much eclipse matter to report. The approach to our destined spot, namely, Neiafu, was beautiful in the extreme. The numerous islands of various sizes which form this large group opened out one by one. Some amounted only to rocks sticking up out of the water, whilst others extended over several acres, and were densely covered with trees, the useful cocoanut palms towering above them. Every island was so luxuriant with this thick verdure that I began to think we should have to utilise some of the ground at the Neiafu village itself.

Hunga on our port side and Nua Papu on the starboard were the first two large islands we passed, and then we took a more easterly course and came to the large island of Vavau, with the conspicuous hill called Moungalafa ahead. We entered a narrow channel separating the island of Pangai Motu from Vavau. Passing up this channel, it looked as if further progress would be impossible. Right ahead were two pyramid-shaped landmarks at the foot of Kilikili, a hill 220 feet high, and here was the gate to the chief town Neiafu; the channel became still more narrow, until it looked as if the good ship *Encounter* would be too large to swing round to go through the small entrance. In fact, it was a case of turning a sharp corner to keep in the middle of the fairway. The manœuvre was splendidly made, and we slipped into this nearly land-locked harbour; looking back, one began to wonder how it had been accomplished, so invisible was the entrance.

Well, here we were at Neiafu at last. Our anchor was dropped at 3.40 p.m. on April 2, and before us lay a picturesque-looking island town, with numerous flags flying over the houses.

It was not long before the health officer, Dr. Anderson, pushed off from the shore, for he had heard the gun which is always fired as soon as a ship is seen coming into the harbour. He was pulled out to the ship by a crew of finely built Tongans. It was noticeable that all, even the doctor, were covered with hundreds of flies, and these (including mosquitoes) I later found to be the most populous inhabitants ashore.

Dr. Anderson told us that "measles" had been passing through Vavau, and that there were still a few cases, one of them being a European who was in hospital. This news suggested that it would be policy to find a site for our eclipse camp somewhere out of the town. Dr. Anderson kindly placed the ground about his house at my disposal for a site for the instruments, but when I inspected it later in the afternoon I found that it was not large enough, and unsuitable for so large a party. In fact, when I was ashore I could see no site that was at once a favourable spot. Mr. Worthington and Mr. Cruickshank, who had preceded us from England to observe the eclipse, had already been on the island some three weeks, and we visited their living tents and eclipse site, which were in the heart of the village.

Before reaching Vavau I had carefully studied the chart of the region, and came to the conclusion that it was well worth while visiting the spot, marked as an Admiralty coaling station, about a mile from Neiafu. Here I thought we should be free from all the disadvantages of a native town. The same evening I dined alone with the captain, and we determined that this site should be inspected.

<sup>1</sup> Continued from p. 463.

Accordingly, next morning, April 3, the captain, Mr. McClean, Fathers Cortie and Pigot, and myself set off in the steamboat and landed up the boat passage near the coaling ground called Umuna. We found that part of the ground was fairly level, high up, and partially cleared, and that by cutting down only about six cocoanut trees and doing a small amount of scrub clearing we should have a first-rate observing station. It did not seem difficult either to find a place where our instruments could be landed, so while Captain Colomb returned to the ship to meet the Governor, Mr. McClean, Father Pigot, and I remained and explored the seashore for possible landing places. In most places there was a steep coral front, but at Bai bai we found an admirable spot, and very close to the site. Fortunately, the captain returned to the ground with the Governor while we were still making investigations. The Governor, who is a native, and communicated with us by means of a native interpreter, told us that the ground was Admiralty property, and that the native who used it as a garden was only a kind of caretaker. This made things easy, for we were then entitled to cut down the necessary trees and make any clearing that was required. Most suitable and

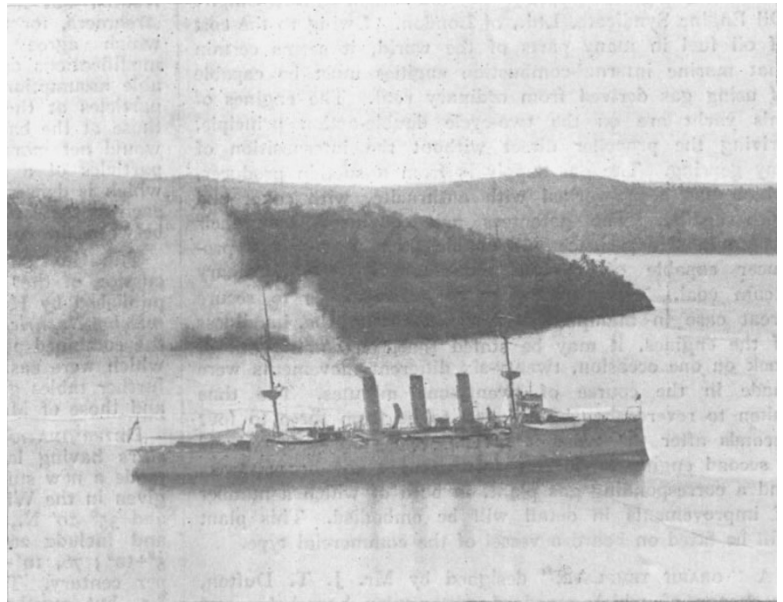


FIG. 1.—The position taken up by H.M.S. *Encounter* close to the Eclipse Station. The photograph was taken from the Hill Muikilekila, 120 feet high.

picturesque places for the guards' camp, the living tents for the shore astronomical party, and other spots for the captain's wife and the officers' wives, who were coming from Australia, could be seen at a glance. In fact, the site could not really have been a better one, and the soil on which the instruments were to be placed was sufficiently rigid and dried very hard. The result of this inspection was so eminently satisfactory to the captain, Father Cortie, and myself that the first-named decided to move the ship right up the harbour and lay her off the observatory site.

The same afternoon anchor was weighed, and we steamed slowly up this beautiful inland sea, dropping it again at the mooring mark, which had been placed in position by the navigating officer, Lieut. Hurst, as a result of his survey in the morning. A shore party, including officers, then went off to the site to get a general idea of the nature of the selected spot.

Tuesday, April 4, was a very busy day. Clearing the ground was at once taken in hand, and a path was cut straight down to the spot selected for landing the cases. Numerous natives came on the scene to clear away the yams, a kind of bread fruit, which were growing on the site. A party from the ship set to work to erect the living tents. The site for Captain and Mrs. Colomb's quarters, selected by the Governor, had been previously

cleared by the local authorities. Great signs of activity were being shown, for the Union Steamship *Atua* was due to arrive in the afternoon with the officers' wives and three members of my party, namely, Messrs. Brooks, Raymond, and Winklemann. Owing to the living accommodation on shore not being quite ready, Captain Colomb kindly permitted the latter three to remain on the ship that night. The *Atua* brought also a portion of the Australian party, namely, Messrs. Moors, Merfield, Holloway, Paradise, and Burne, the site of whose camp had been settled near the Catholic Mission Church at Neiafu.

Since we arrived it has been very hot. On shore it is comparatively cool up to about 7 a.m. The temperature, however, quickly rises after, and between two and four o'clock in the afternoon it is extremely hot, the thermometer being at a maximum about 3.30 p.m. The two self-recording instruments which I set up in the camp tell us the temperature and the humidity of the shade air. The daily curves of these are the reverse of each other, the temperature rising when the humidity is falling. This is very fortunate, for the humidity is always high and the shade temperature at a daily maximum of about 86°. The self-recording barograph I still keep in my cabin on

tion, and these were felled the same afternoon; it has only been found necessary at the time of writing to cut down five altogether. On Wednesday a record, so far as I am aware, has been broken in eclipse expeditions with a man-of-war, for the guards' camp ashore and the ship have been connected by telephone, most of the cable being under water; on previous occasions a signal station and flag waving was the procedure adopted. Until to-day, Messrs. Brooks, Raymond, and Winklemann of my party have been sleeping ashore, as the three tents were fully prepared. To-day two more tents were completed, so Mr. McClean and Mr. Anderson joined them, and I still remained on board at night. The row of seven tents and the large mess tent dotted among the cocoanut trees, and situated on the trade-wind side of the hill, forms a very pretty picture and a cool spot when one has been on the eclipse site for some time. Flies and mosquitoes are there, however, in abundance, and spiders, large and small, galore.

The dark-room lies in a cool shady corner near the living camp. This position was chosen as all water has to come from the ship, and most of it daily goes to the living quarters, so labour is saved. To-day the positions of all the large instruments were carefully pegged out, and parties were sent to skirmish for sand and deal coral for the pillars, which will be erected immediately. Mr. Brooks has been busy with his theodolite, laying out the north and south lines for the siderostats and the correct azimuths for the coelostats. To-day a crow's-nest has been erected on a tall cocoanut tree overlooking the ground, so that our hard-working photographer, Mr. Winklemann, and his two assistants can secure a good view of the whole eclipse camp as it progresses daily.

After consultation with my party, I have decided to sleep on board at night, so as to be a link between the ship and the shore party. This I consider to be advisable, as we require so much material and help each day. To-night three sharks were swimming about the ship, and many lines with hooks and pork were over the sides to tempt these hated brutes. Although almost daily sharks are present, no catch has been successful yet. According to the statements made by the Europeans here, the Tongans can call the sharks by uttering native words. We have not seen this put into practice, but there is yet time.

Daily we have quite a lot of small fracto-cumuli clouds moving slowly across us, but the weather is thoroughly hot and tropical. Those living here inform us that we are having rather abnormally fine weather, as was the case in Australia. The weather, therefore, seems to be abnormal in this portion of the southern hemisphere, and we are hoping that the fates will be kind to us when we come to eclipse day.

Every day the camp shows great signs of progress. Levelling, making concrete pillars, covering small huts with willerden canvas, and similar operations being in progress. On April 7 several parties who could be freed from the eclipse camp went off collecting for the "ologies" specimens of coral, flowers, butterflies, fossils, shells, &c. This specimen collecting is taken up very keenly, and I hope to have a good selection to bring back. The navigating officer is leaving the ship next week with a diving staff for Nukualofa to help salvage the ss. *Bouveric*, which has piled up on a coral reef. The captain was asked whether the *Encounter* could assist, but in reply to his message to the Admiralty for instructions he was informed that he could only render assistance if it did not affect the eclipse parties. At our present site we are now entirely dependent on the ship, and most especially for water, so Captain Colomb has decided that Lieut. Hurst, the navigator, should go by mail steamer and do what he can with divers and



FIG. 2.—The shore party's tents on the east side of the hill on which is situated the observatory station. The marks from left to right when looking at the photograph indicate 1.—1. Brother McKeon. 2. Dr. W. J. S. Lockyer. 3. Mr. Raymond. 4. Mr. Brooks. 5. Lieut. Clover. 6. Mr. F. K. McClean.

board, and this is daily marking out the two small diurnal oscillations with a long secular wave extending over many days.

Wednesday, April 5, was occupied mainly in bringing all the instrumental gear from the ship to the instrument tents ashore. A most effective method was adopted to obviate the difficulty of the rise and fall of the tide: a landing stage jutting out several yards was improvised, and the boats came alongside and discharged their cargo. Block and tackle and a stout tree at the top of the 20-foot sharp rise at the shore, coupled with the strength of several hale and hearty bluejackets, quickly settled the question of hauling the cases up the inclined spars. If the cases were not too heavy, two men with one case slung over a spar carried it to the camp, whilst if it were rather heavy the limber from the gun (which had been previously landed) and a team of bluejackets made short work of it all. Working from 8.30 a.m. to 11.30 a.m., and from 2.30 p.m. to 4.30 p.m., both Father Cortie's cases and mine were all transferred from the ship to the instrument tents. In this way eclipsing is made very easy.

Up to this time no cocoanut trees had been cut down, as it was desired to preserve as many as possible, for each tree brings in an annual income of four shillings a year and takes six years to grow to a bearing condition. However, four trees had to come down as a first approxima-



explosives. Lieut. Hurst was a volunteer for the time determination as observed by the cusps, so he has now been replaced by Lieut. Clover.

On the evening of April 7 Commander Mellor, Father Cortie, and I went ashore after dinner to Neiafu to inquire about Prof. Moor, one of the Australian party, who had an accident yesterday. It seems that after a hard day's work he went to bathe, and while undressing fell from the

kedged that the wind strikes the starboard side; the port side is therefore the sunny and leeward side. The temperature in my cabin, with scuttle open and electric fan working, varies during the day time from about 84° to 90° F.

Unfortunately, on Monday Mr. Brooks, while chopping a piece of wood with an axe, cut his left-hand thumb badly. Staff-Surgeon Milln soon stitched it up for him when he got on board.

In the evening, during dinner, clouds appeared in the east, indicative of vertical currents, very tall cumuli clouds with flat bottoms. The wind began gradually to increase from a slight zephyr to a cooling breeze, and became fairly strong about 9.30 p.m., and the rain came down in torrents. While thinking of those living ashore and the instruments, we had to rush to remove our bunks from the deck, for the awning was of no apparent use.

This shower gave me some idea of how it can rain here, although up to now we have experienced very little of it. I made up my mind, therefore, to prepare for all eventualities. Thus Tuesday morning was chiefly spent in digging trenches. Fortunately, the dark-room had previously been dealt with in this manner, and could not be washed out. That afternoon was the climax. Down the rain came again in torrents. Mr. McClean and I went round the camp to see that all was in order, and at the same time obtained a good idea of what to do in the future.

Although these rain squalls may not be numerous, they are tremendously heavy when they do come, and one thickness of canvas barely keeps the rain out. Fortunately, the ship can supply a great number of small waterproof coverings, and I expect we shall indent for most of them. Even to-day (April 12) rain has been frequent, and prevented much opening up of instruments. The sky was completely overcast in the early



FIG. 3.—Preparing concrete for the pillars. Sand, cement, and dead coral (the last-mentioned quarried from the top of the hill) were used.

bathing platform into very shallow water on to coral. He not only cut the back of his head badly, but his back, and he was in bed suffering from concussion. He is now (April 12) progressing, but he is suffering with his sight, and may have to return to Australia by the next steamer.

After another hard day's work on Saturday, when good progress was made in all directions, Sunday was considered a day of rest. Mr. McClean and Mr. Brooks preferred to stay ashore, Mr. Raymond and Mr. Winklemann went to Neiafu photographing, while Mr. Anderson and I went off for a sailing picnic with some of the officers. We visited the famous "Swallows" Cave; hundreds of swallows flew out as we rowed in. The cave is of considerable dimensions, and its upper portion is a mass of stalactites. One projects vertically upwards from a ledge on the side, and when hit with a boat-hook it gives out a beautiful low tone like a large bell. The water in this cave is very deep and clear, and when it was thought no sharks were about some of the party indulged in a bathe. Lunch was partaken on a small sandy beach a mile or so away in the presence of thousands of flies, and there I made a collection of several shells and seeds. On our return in the evening we again entered "Swallows" Cave, as the sun was well round and shining nearly in it. The colours of the water were superb, but the heat and the innumerable mosquitoes and flies made our stay shorter than we intended.

On Monday (April 10) at 2 a.m. very heavy rain fell, but as there was little wind and my bunk was placed well in the middle of the quarter-deck, I did not wake. Every night many of us sleep on the quarter-deck or after-bridge, and we dine on the former also. The ward-room gets very hot after the day's sunning, and the ship is so

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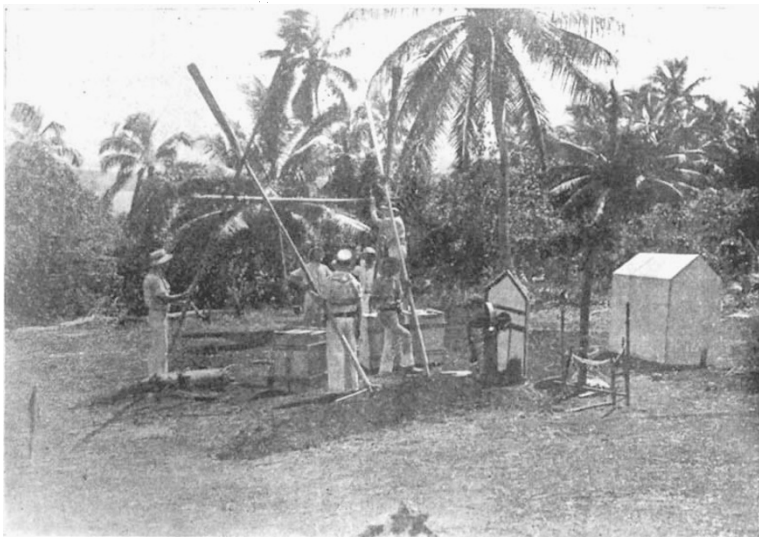


FIG. 4.—The 6-in. prismatic camera in course of erection.

morning, and all day blue sky has been rarely seen. Later in the afternoon we had another deluge; but now we are well prepared, and do not mind so much. The humidity here is very high, and everything exposed to the air quickly rusts, even keys in one's pockets.

Nevertheless, we are all a very cheerful party, and the assistance from the ship is magnificent. This evening the *Tofua* is expected to arrive, bringing more of the

Australian party, namely, Messrs. Baracchi, Cooke, Dodwell, Kenney, and Beattie, and Mr. Short for Worthington's party. This is the last post until after the eclipse. We will do our best to keep the flag flying on that eventful day, but we must have a clear sky.

W. J. S. LOCKYER.

N.B.—The photographs accompanying this letter were all taken (with one exception) by Mr. Winklemann. They were printed by a bluejacket on board H.M.S. *Encounter*, as conditions were not favourable for the process ashore. This bluejacket is a volunteer for our photographic department, and a very valuable one.

W. J. S. L.

### PHYSIOGRAPHIC STUDIES IN THE FRENCH ALPS.

THE former of the two memoirs included in the publication before us is a report by MM. Flusin and Bernard upon an apparatus for boring into a glacier, devised by MM. Hess and Blümcke, the working of which they had studied on the Hintereisferner in the Austrian Tirol. As the scientific interest of this is at present more indirect than direct, we may pass on to the second memoir, "Etudes Glaciaires Géographiques et Botaniques dans le Massif des Grandes Rousses," by MM. Flusin, Jacob, and Offner.

The Grandes Rousses is a rather lofty and insulated range in the French Alps, which rises on the right bank of the Romanche, roughly north-east of Bourg d'Oisans. On its jagged crest, which runs approximately from N.N.E. to S.S.W., two peaks, though some distance apart, attain the same altitude—11,395 feet. Its western side descends more abruptly than the eastern, so the glaciers on the former are shorter and steeper than on the other. It is an island ridge of crystalline rock—granites more or less gneissoid, and schists—rising from a hilly district of Lower Mesozoic (chiefly Liassic) rocks, mainly, no doubt, a result of the second of the two great folding processes which have given birth to the Alpine chain.

First in order, to the west of the watershed between France and Italy, is the great mass of crystalline peaks which rise around the headwaters of the Vénéon—two of them, the Ecrins and Meije, exceeding 13,000 feet in height—and are linked by the Col du Lautaret to the mountains south of the Arc. Farther west is the range of the Grandes Rousses, and still farther in that direction, separated by another syncline of Mesozoic rock, comes that of the Belledonne, the highest peak on which attains 9781 feet. The Ecrins *massif* is probably an extension (though perhaps not a simple one) of the Mont Blanc axis; the Grandes Rousses and the Belledonne, a prolongation of that of the Arguilles Rouges, which has either bifurcated or raised up another earth-wave in front. But the Grandes Rousses *massif* affords evidence of a much more ancient system of disturbances, for two strips of Carboniferous rocks (as may be seen in the valley of the Romanche) are sharply infolded in the crystalline series—just as occurs in the valley of the Rhone and on the way from Vernayaz to the Tête Noire. The author attributes this folding to the Hercynian movements, though its strike is much more nearly north and south than east and west. It was, at any rate, succeeded by enormous denudation, for in this part of the Alps the base of the Mesozoic series may be seen resting on the denuded edges of these huge folds.

The report includes a study of the Alpine plants in the three regions or stages into which the range may be divided, and a very full account of the snowfields and glaciers. The snow-line, of course, varies in different localities, but the authors take 8720 feet as an average, which very nearly coincides with the limit of the *névé*, that is, where ablation balances accumulation, or expenditure just exhausts income in the matter of snow. This limit, they point out, rises as the altitude of a group increases, being about 650 feet higher in the Grandes Rousses than in the Belledonne, while in the eastern

<sup>1</sup> Ministère de l'Agriculture—Direction de L'Hydraulique et de Améliorations Agricoles—Service d'Etudes des Grandes Forces Hydrauliques (Région des Alpes)—Etudes Glaciologiques. Tirol Autrichien. Massif des Grandes Rousses. Pp. vi+112 + ix plates + ix panorama views (1909).

*massif* it overtops the former by 400 or 500 feet, a result which seems to call for explanation. Particulars also of the retreat of the glaciers are given, with maps and some interesting photographs; in short, the memoir is a most elaborate one, though we cannot forbear remarking that if a similar exhaustive treatment is applied to other parts of the Alps—and the practice seems to be growing—conscientious students will before long often have to choose between hours in a library and work in the field.

T. G. B.

### THE MOVEMENT OF SUBSOIL WATER.<sup>1</sup>

IN all densely populated areas the water supply is a matter of primary importance, especially where the rainfall is scanty, and where a large proportion of the supply is derived from shallow wells. Dr. W. F. Smeeth, of the Geological Department of Mysore, has prepared a report dealing with this subject, which is based upon observations made during the year 1909, so that it provides rather a basis for further study than a complete discussion of the subject. The Mysore plateau extends over some 29,400 square miles, and is composed almost entirely of gneisses, granites, and crystalline schists, which are more or less decomposed to a depth of from 50 to in some places as much as 100 feet; the upper 50 feet of this forms a reservoir which is fed by the rainfall, and will hold a quantity of water varying with the porosity of the materials, and from it the wells derive their supply. On account of the seasonal character of the rainfall the level of the water-table varies considerably, and from various considerations the author takes a zone of intermittent saturation having a mean depth of 10 feet, and an average porosity of 12 per cent., as representing the average conditions which occur.

The rainfall varies greatly, from 73.21 inches in the west to 21.27 inches in the east of the area, and from the average variation of the water-level in wells, compared with a ground water supply which is taken as equal to 10 per cent. of the variation in the water level in each district, a "percolation factor" is obtained. No river discharges are included, nor is evaporation determined in order to obtain an independent value of the amount accounted for by percolation, which by the method employed is given as from 19.9 to 66.7 per cent. of the average rainfall. The rainfall also differs considerably in type in different portions of the area, having a strongly marked maximum in July due to the south-west monsoon in the west, while in the east the rainfall of the north-east monsoon in September and October is more important.

Observations were collected so far as possible from all villages, and 2563 wells were recorded from which fairly representative deductions for the year under investigation were possible. The mean depth of the water from the surface varied from about 38 to 4 feet, the mean values for maximum and minimum depths being 30 and 18, while the mean variation in the course of the year was 12.4 feet, and 37.5 per cent. of the wells were reported as drying up during the year. The variations of level ranged from an average of 15.3 feet for shallow wells in which the minimum depth to water-level was under 10 feet, to 8.2 feet in those where it was over 40 feet. Details of the water met with in the Mysore mines is included, but not much is deducible from such information at present. A series of diagrams show the position of the maximum and minimum water-levels in the village wells observed, and it is clear that a large number of them do not reach the depressed water-table of the dry season, since the conditions are not realised by the well owners. Deeper and fewer wells are recommended with pumping where necessary, and a systematic distribution of the permanent supply so obtained. Further investigation is recommended for the seasonal variation of water-level in different districts has not been considered. While diagrams are abundant, maps of the region, whether topographical, orographical, or showing the distribution of the rainfall, are conspicuous by their absence, and render a satisfactory study of the report difficult.

Although the Nile and its system of canals provide most

<sup>1</sup> "Notes on the Underground Water Resources in Mysore." By Dr. W. F. Smeeth. Pp. 69, plates 1-69. (Government Press, 1911.)