

REPORT

OF THE

FORTIETH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT

LIVERPOOL IN SEPTEMBER 1870.

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1871.

in consequence of its not possessing central offices in London, where its Council and numerous committees could hold their meetings, where the books and memoirs which have been accumulating for years could be rendered accessible to Members, and where information concerning the Association's proceedings could be promptly obtained during the interval between annual meetings. The Council have had the subject under consideration, and in the event of the establishment at Kew being discontinued, they are prepared to recommend that suitable rooms, in a central situation, should be procured. The additional annual expenditure which this would involve would probably not exceed £150.

The Council having been informed by the Local Officers of their desire to have Mr. Reginald Harrison appointed as an additional Local Secretary, to assist in making arrangements for the present Meeting, have nominated that gentleman to the office.

Mr. Arnold Baruchson and Mr. Wm. Crosfield, Jun., have also been nominated Local Treasurers, *vice* Mr. Duckworth resigned.

The Council have added the names of Professor H. A. Newton and Professor C. S. Lyman, who were present at the Exeter Meeting, to the list of Corresponding Members.

*Report of the Kew Committee of the British Association for the
Advancement of Science for 1869-70.*

The Committee of the Kew Observatory submit to the Council of the British Association the following statement of their proceedings during the past year:—

At the Meeting of the General Committee at Exeter it was resolved that the existing relations between the Kew Committee and the British Association be referred to the Council to report thereon.

In consequence of this resolution, the Kew Committee on the 23rd November, 1869, prepared for the information of the Council a statement on the past and present condition of the Observatory, which was presented to the Council on the 11th December.

In this statement it was shown that while the establishment at Kew Observatory received its main support from the British Association, and was under the control of that body, yet much of the apparatus in use at Kew was furnished from other sources. Thus the Royal Society had from the Government-Grant Fund supplied the establishment with the apparatus for testing Barometers, with that for testing Sextants, with the dividing-machine for constructing Standard Thermometers, and also with the set of Self-recording Magnetographs at present in use, while from the Donation Fund they had furnished the Photoheliograph and the Whitworth lathe and planing-machine.

The Royal Society had likewise defrayed from the Donation Fund the expense of introducing gas into the Observatory, and of building a house for the verification of magnetic instruments, besides which they had borne from the Government-Grant Fund since 1863 the whole expense of working the Photoheliograph (including the purchase of a Chronometer) and of reducing its results.

The instruments used at Kew for determining the absolute magnetic elements are the property of Her Majesty's Government, and have been lent

to the Kew Observatory by the Magnetic Office at Woolwich, under the direction of Sir E. Sabine, and many of those magnetic instruments with which Kew has been the means of furnishing scientific travellers have been derived from the same source.

Of late Kew has become the Central Observatory of the Meteorological Committee, and a commodious workshop has been erected near the Observatory by that Committee, since otherwise the main building would have been too small for the access of work consequent upon the arrangement entered into.

The statement prepared by the Kew Committee contained likewise a summary of the scientific work done at the Observatory, as well as some interesting historical remarks connected with the origin of the establishment, drawn up by Sir C. Wheatstone, and in this shape it was submitted to the Council of the British Association.

The Council decided to recommend "that the present relations between the Kew Observatory and the British Association be continued unaltered until the completion, in 1872, of the magnetical and solar decennial period; that after that date all connexion between them should cease."

In consequence of this recommendation, the Kew Committee were led to contemplate the dissolution of the Kew establishment in 1872, and they became anxious to make such arrangements as might enable them to complete their scientific labours in a creditable manner before the time of the anticipated dissolution. The magnetic work in particular caused them anxiety; for the annual income of the establishment is insufficient to permit of that work being fully completed by the time of the Annual Meeting of the Association in 1872. Under these circumstances the Chairman offered to supplement the deficiency (see Appendix, p. lvi). It will be seen by this Report that the magnetical tabulations and reductions are now proceeding very fast.

The recommendation of the Council was also a matter of anxiety to the Superintendent, Mr. Stewart; and as the Professorship of Natural Philosophy at Owens College, Manchester, became vacant about this time, he applied for the appointment and was successful in obtaining it.

This will render it necessary for Mr. Stewart to reside in Manchester, but the staff at the Observatory are such that Mr. Stewart will undertake by their aid to assist the Committee in the superintendence of the work of the Observatory until 1872.

(A) WORK DONE BY KEW OBSERVATORY UNDER THE DIRECTION OF THE BRITISH ASSOCIATION.

1. *Magnetic Work.*—In the present state of magnetical science it would appear to be desirable to preserve as completely as possible the details of observations, so that future theorists may have a large and valuable source of information by which to test their speculations.

The Committee are therefore desirous that by the autumn of 1872 a manuscript record should be completed, containing all the hourly tabulated values from the Kew Magnetographs arranged in monthly tables.

This record should be carefully preserved, along with the original photographic traces, in the Archives of the Association.

Pursuing the method indicated by Sir E. Sabine, and adopting the separating values finally determined by him, the Committee further propose to obtain monthly results indicating the following points for each of the three magnetic elements, distributed according to the hour of the day:—

1. Aggregate of disturbance tending to increase the numerical values.
2. Aggregate of disturbance tending to decrease the same.
3. Solar-diurnal range of the undisturbed observations.

They suggest that the monthly results embodying these facts should be published in detail.

Finally, they propose to continue the discussion of the Lunar-Diurnal variations commenced by Sir E. Sabine, and carried on by him up to the end of the year 1864. In order to work this scheme with sufficient rapidity to complete it before the autumn of 1872, additional assistance has been procured, the expense of which has been defrayed by the Chairman. Mr. Whipple, Magnetic Assistant, has displayed much zeal and ability in organizing the work and in superintending its immediate execution.

Already the hourly numerical values of the three magnetic elements have been obtained and tabulated in monthly forms from the commencement of the series in 1858 to the present date; and considerable progress has also been made in the next step of the reduction.

A Unifilar, formerly employed by Captain Haig, and of which the constants have been determined at the Observatory, has been lent to Lieut. Elagin, of the Russian Navy, for use in the Japanese seas and elsewhere.

A Dip-circle by Dover has been verified and sent to Prof. Jelinek, of Vienna, and another, by the same maker, has been verified for Dr. A. B. Meyer, for use in the East Indies. This gentleman has likewise received magnetic instruction at the Observatory.

A Dip-circle by Adie, furnished with a deflecting cylinder apparatus, has been verified and dispatched to Prof. Bolzani, of the University of Kasan.

Three Dipping-needles have likewise been constructed for Dr. Bergsma, of Batavia, and one for Mr. Chambers, of the Colaba Observatory, Bombay.

A Deflection-bar has been procured and verified for the Russian Central Observatory. A Declinometer has been sent to the Lisbon Observatory, and a Fox's Circle has been lent to Dr. Neumayer, after having been repaired by Adie.

The instrument devised by Mr. Broun for the purpose of estimating the magnetic dip by means of soft iron, and constructed at the expense of the British Association in pursuance of a resolution of that Body passed at the Oxford Meeting, has been forwarded to that gentleman at his request.

The usual monthly absolute determinations of the magnetic elements continue to be made by Mr. Whipple, Magnetic Assistant.

A paper embodying the results of the absolute observations of Dip and Horizontal Force, made at Kew from April 1863 to April 1869, has been communicated by the Superintendent to the Royal Society, and published in the 'Proceedings' of that body. The results obtained evidence the accuracy with which the monthly observations have been made by Mr. Whipple.

The Self-recording Magnetographs are in constant operation as heretofore, also under his charge; and the photographic department connected with these instruments remains under the charge of Mr. Page.

2. *Meteorological work.*—The meteorological work of the Observatory continues in the charge of Mr. Baker.

Since the Exeter Meeting, 150 Barometers have been verified, and 30 have been rejected; 1160 Thermometers and 103 Hydrometers have likewise been verified. Nineteen Standard Thermometers have been constructed for Prof. Tait, and two for the Meteorological Office.

The self-recording meteorological instruments now in work at Kew will

be again mentioned in the second division of this Report. These are in the charge of Mr. Baker, the photography being superintended by Mr. Page.

3. *Photoheliograph*.—The Kew Heliograph, in charge of Mr. Warren De La Rue, continues to be worked in a satisfactory manner. During the past year 351 pictures have been taken on 237 days.

It was considered desirable that six prints should be obtained from each of the negatives of the sun-pictures taken at the Observatory during the whole time that the Photoheliograph should remain at work, which will probably be from February 1862 to February 1872.

In order to accomplish this, an outlay of £120 spread over two years was found to be necessary, and this sum has been voted from the Donation Fund of the Royal Society.

A large number of these prints has already been obtained, and it is proposed to present complete sets to the following institutions:—

The Royal Astronomical Society,
 The Imperial Academy of Paris,
 The Imperial Academy of St. Petersburg,
 The Royal Society of Berlin,
 The Smithsonian Institution, United States,

leaving one set for the Royal Society.

A paper embodying the positions and areas of the sun-groups observed at Kew during the years 1864, 1865, and 1866, as well as fortnightly values of the spotted solar area from 1832 to 1868, has been communicated to the Royal Society by Messrs. Warren De La Rue, Stewart, and Loewy.

This paper is in the course of publication in the *Philosophical Transactions*, and will shortly be distributed.

A Table exhibiting the number of sun-spots recorded at Kew during the year 1869, after the manner of Hofrath Schwabe, has been communicated to the Astronomical Society, and published in their *Monthly Notices*,

M. Otto Struve, Director of the Imperial Observatory at Pulkowa, visited England in the month of August last. He brought with him, for the Kew Observatory, some sun-pictures made at Wilna with the photoheliograph, which, it will be recollected, was made some years ago, under the direction of Mr. De La Rue, by Mr. Dallmeyer. This instrument combines several important improvements on the original Kew model, the value of which is forcibly brought out in the superior definition of the Wilna sun-pictures. As, however, the series of the ten-yearly record at Kew was commenced with the instrument as originally constructed, it was not deemed desirable to alter it in any way until the series had been completed and reduced, and the corrections for optical distortion ascertained and applied. In the event of the sun-work being continued after 1872, it will be desirable to do so with a new and improved heliograph.

M. O. Struve proposed to exchange the complete series of pictures obtained at Wilna for that made at Kew. He also stated that it is contemplated to erect a second heliograph at the Central Observatory at Pulkowa.

4. *Miscellaneous Work*.—A few experiments have been made on the rotation of a disk *in vacuo*. By an arrangement devised by Mr. Beckley, a very perfect carbonic-acid vacuum has been obtained, the residual pressure being 0.02 inch as indicated by a mercurial gauge with a contracted tube, but it was believed that the vacuum was even more perfect.

A disk of paper and one of ebonite gave very sensible heat effects in such a vacuum, and it was hoped that the experiments might have been satisfac-

torily completed; but while they were in progress the pressure of the outer atmosphere shattered the receiver into a number of pieces, fortunately without any injury to the experimenters.

Another receiver has now been made, and it is purposed in future to use it with a cover.

A Transit instrument has been lent to Mr. G. J. Symons, and one Sextant has been verified.

(B) WORK DONE AT KEW AS THE CENTRAL OBSERVATORY OF THE METEOROLOGICAL COMMITTEE.

It is stated in the Report for 1867 that the Meteorological Committee had appointed Mr. Balfour Stewart as their Secretary, on the understanding that he should, with the concurrence of the Kew Committee, retain his office of Superintendent of the Kew Observatory.

On the 8th October, 1869, Mr. Stewart resigned his appointment as Secretary to the Meteorological Committee and Director of their Central Observatory—a step which took effect on 31st of March, 1870, and which was followed by a modification of the relation between the two Committees.

The Meteorological Committee, at their Meeting on 12th November, 1869, resolved that they were prepared to make the following proposals to the Council of the British Association:—

I. That Kew be continued as one of the ordinary self-recording observatories, in which case the Committee would be prepared to allot to it annually £250; or,

II. In addition to the foregoing work, that Kew be maintained as the central observatory for examination of records and tabulations from all the other observatories, in which case the Committee will be prepared to allot a further annual sum of £400.

The Kew Committee having been furnished with this resolution of the Meteorological Committee, resolved that it be recommended to the Council of the British Association that Kew be continued for the next two years as one of the ordinary self-recording observatories of the Meteorological Committee, that body allowing it annually £250; and that, in addition, it be maintained as the central observatory for the examination of the records and tabulations from all the other observatories, for the further sum of £400 per annum. This arrangement was approved by the Council; and it was thereupon resolved by the Kew Committee, that out of the £650 received from the Meteorological Committee, £200 be given to Mr. Stewart for superintending the meteorological work of the Observatory, this resolution to take effect after 31st March, 1870.

1. *Work done at Kew as one of the Observatories of the Meteorological Committee.*—The Barograph, Thermograph, and Anemograph furnished by the Meteorological Committee are kept in constant operation. Mr. Baker is in charge of these instruments. From the first two instruments traces in duplicate are obtained, one set being sent to the Meteorological Office and one retained at Kew; as regards the Anemograph, the original records are sent, while a copy by hand of these on tracing-paper is retained. The tabulations from the curves of the Kew instrument are made by Messrs. Baker, Page, and Foster.

2. *Verification of Records.*—The system of Checks devised by the Kew Committee for testing the accuracy of the observations made at the different Observatories continues to be followed, the only alteration being that the Kew
1870. d

Staff, at the suggestion of the Meteorological Office, have undertaken to rule on the Barograms and Thermograms a set of zero lines, which are of great use in Pantagraphic operations.

Mr. Rigby continues to perform the main part of this work; Mr. Baker, Meteorological Assistant, having the general superintendence of the department.

3. *Occasional Assistance.*—The Meteorological Committee have availed themselves of the permission to have the occasional services of Mr. Beckley, Mechanical Assistant at Kew; and he has lately been visiting the various Observatories of the Meteorological Committee.

The Self-recording Rain-gauge mentioned in last Report as having been devised by Mr. Beckley has been adopted by the Meteorological Committee, and instruments of this kind are at present being constructed for their various Observatories.

The Staff at Kew continue to make occasional absolute hygrometrical observations by means of Regnault's instrument, with the view of testing the accuracy of the method of deducing the dew-point from the observations with the dry- and wet-bulb thermometers.

Two erections have been made in the grounds adjoining the Observatory; and on one of these a large Robinson's Anemometer is placed, while a small instrument of the same kind is placed on the other.

By this means the indications of the large and those of the small-sized instrument may be compared with each other. The cost of this experiment has been defrayed by the Meteorological Committee.

J. P. GASSIOT,
Chairman.

Kew Observatory,
9th September, 1870.

Appendix to Kew Report of 9th September, 1870.

At the Meeting of the Kew Committee held at Burlington House on 2nd March 1870, it was Resolved that the remarks by Sir E. Sabine and Mr. Stewart be printed, along with extracts from the Report for 1866-67, and from the Minutes of June 18, 1869; and that copies be forwarded to the several Members of the Committee, with a statement by Mr. Stewart as to the manner in which he proposes to complete the reductions, so as to carry out the Resolutions of the Committee.

No. 1.

Memorandum by General Sir E. Sabine regarding the Investigations for which the loan of the Kew Photograms from 1857 to 1862 was requested.

March 1, 1870.

THE photograms here referred to were duly received at Woolwich, and duly returned to Kew; Mr. Gassiot has a paper stating the dates at which the several photograms were returned to Kew.

The investigations for which these documents were temporarily borrowed formed the substance of a paper presented to the Royal Society in June 1863, and printed in the Philosophical Transactions of that year (Art. XII.). The

1st Section contained a Tabular Synopsis of *ninety-five* of the principal disturbances of the Declination recorded by the Kew photograms from January 1858 to December 1862, with a comparison of the Laws of the Disturbances derived therefrom with the Laws derived by the more usual method then practised. The tabular summary at the close of Section 1 shows the resulting aggregate values both of Easterly and of Westerly disturbance at each of the 24 hours (or at 24 equidistant epochs) in each of the five years, as well as in the whole period. It is strictly a tabular detail for the period in question, showing the *Disturbance-diurnal Variation* as it would result if the investigation were limited to the 95 most disturbed days, and may be considered to represent the mode of investigation then practised by some magneticians.

The 2nd Section of the paper compared the Laws of the Disturbances thus obtained with the Laws derived from a wider selection of disturbed observations; *i. e.* a selection including every anomalous record of which the anomalous character cannot with probability be ascribed to any other source than that of the disturbing action whose laws are sought. This Section is also accompanied by a tabular statement in full detail; and from an examination of the contents of the 1st and 2nd Sections the following conclusions are drawn:—

1. That the disturbances have *systematic laws* :
2. That both easterly and westerly deflections have each their own systematic laws, distinct and different each from the other :
3. That the laws are approximately the same, whether derived from the more limited or the more extended selection, though the latter comprises three times as many cases of disturbance as the former.

Hence it is inferred that, by taking into account only the most notable days of disturbance (as was then the practice of some magneticians), an *approximately* correct view of the disturbance-diurnal variation may be obtained; but, if we desire to eliminate the influence of the disturbances on the diurnal variation due to other causes, the more comprehensive method must be adopted.

A selection of this latter character was then made for the five years 1858 to 1862, and the results exhibited, both in tabular and graphical representations; and the laws derived therefrom were compared with corresponding investigations in other parts of the globe.

In the 4th Section of the paper is discussed the “*Diurnal Inequality*,” comprehending 1°, the disturbance-diurnal variation, and 2°, the undisturbed solar-diurnal variation. This discussion may be regarded as exhibiting what should be the *primary step* in the analysis of the periodical variations.

The solar-diurnal variation derived from the record of the five years at Kew, 1858 to 1862, is then compared with solar-diurnal variations similarly obtained at Toronto, Nertschinsk, Peking, St. Helena, the Cape of Good Hope, and Hobarton; and the several points of agreement or difference are discussed.

In the same 4th Section, the *semiannual inequality* which is seen to exist at all the stations enumerated above is discussed, and is shown to manifest a *solar* influence, evidenced by the differences exhibited in different parts of the globe.

In Section 6 the *Lunar-diurnal Variation* derived in each of the five years at Kew is deduced and discussed.

In Section 7 the *Secular Change* and *Annual Variation* of the Declination

are discussed, and a *semiannual variation* is shown to exist having epochs coincident (or nearly so) with the equinoxes—a conclusion which is shown to be in accordance with similar investigations at Hobarton, St. Helena, and the Cape of Good Hope.

The 8th Section establishes the existence of an “annual variation” or “semiannual inequality” of the *Inclination* and of the *horizontal and total Forces*, derived from the observations made at Kew in 1858 to 1862, with instruments which had been supplied by the Magnetic Office at Woolwich, and employed by Mr. Chambers at Kew. The calculation of the Kew results made at the Woolwich Office was shown to be in accordance with the phenomena at Hobarton, St. Helena, and the Cape of Good Hope.

A subsequent paper, communicated by me to the Royal Society in 1866, contained the *Lunar-diurnal Variation* of the three magnetic elements derived from the Kew photograms from January 1858 to December 1864, being an extension of two years upon the records discussed in the former paper, and limited only by the epoch to which the photograms had then been carried, *i. e.* to the close of 1864. The general agreement of the Kew results with those derived at Hobarton and Philadelphia was satisfactorily established by the discussion of the Kew records up to the date of December 1864, and several points of difference in minor respects, requiring further investigation, were indicated: for these the continuation of the Kew photograms, subsequently to December 1864, may be expected to supply the materials.

(a)

What appears now to be required is the continuation of the same process of examination, and comparison with the results obtained at other stations, of the results derivable from the Kew photograms in the years which have elapsed since the investigations were completed of which an account had thus been given.

These additional years are from December 31, 1864, to December 31, 1869, *i. e.* five years. And this is the work which, if I correctly understood the resolution of the Kew Committee, passed (I think) at the Meeting before the last (*viz.* in June 1869), the Superintendent was requested to proceed with.

J. P. Gassiot, Esq.,
Chairman of the Kew Committee.

EDWARD SABINE.

No. 2.

Suggestions by Mr. Stewart as to the best form of Publication of the Results derived from the Traces of the Kew Magnetographs.

In the present state of magnetical science, it would appear to be desirable to preserve as completely as possible the details of the original observations,—a course similar to that which has been pursued by Dr. Neumayer in his description of the results of the Flagstaff Observatory, Melbourne.

Photographic Traces.

The original documents of the Kew Observatory are the photographic traces. As these are supposed to be liable to fade in the course of time, I would suggest that a careful copy of them on tracing-paper would be the simplest and least expensive mode of retaining them. Such a copy would not be sufficiently accurate for investigations regarding peaks and hollows,

but these phenomena will, it is hoped, be investigated before the time when the Observatory ceases to be connected with the British Association.

The curves are as yet all in good order. The whole expense of preserving traces would probably not much exceed £100. And I would suggest that I might with propriety direct to this object a grant of £100 which I have at present in hand from the Royal Society for procuring impressions of magnetic curves.

(b) *Hourly Tabulations from Traces.*

The documents next in order are the hourly tabulated numerical values, as exhibited in monthly tables for each of the elements. Although individual results of this nature have been published by Dr. Neumayer, the cost of the publication of the Kew series in this country would be very great; and bearing in mind the limited reference to such individual results, I would suggest that a carefully preserved manuscript record would probably be sufficient.

(c) *Separation of Disturbances and Solar-Diurnal Variations.*

Pursuing the method indicated by Sir E. Sabine, and adopting the separating value finally determined by him, we should obtain monthly results indicating the following points for each of the three elements, distributed according to the hour of the day:—

1. Aggregate of disturbances tending to increase the numerical values.
2. Aggregate of disturbances tending to diminish the same.
3. Solar-diurnal range of the undisturbed observations.

I would suggest that the monthly results embodying these facts should be published in detail. The publication would not probably occupy more than thirty-six quarto pages well filled with figures.

Lunar-Diurnal Variations.

Adopting Sir E. Sabine's method of treating these, I would suggest, in addition, a classification according to the relative position of the sun and moon. We might perhaps have quarterly means of lunar days, each quarter being divided into four groups representing the four well-known relative positions of the sun and moon.

This might occupy about fifteen quarto pages well filled with figures.

(d) *Secular Change and Semiannual Inequality.*

Presuming that these elements are best determined for the two components of magnetic force from the absolute observations, I would suggest that, as regards the declination, Sir E. Sabine's plan be pursued. As he has already given the details of his results up to the end of 1863, it would only be necessary to continue these up to the time when the series is complete.

Remarks on the above.

If a condensed series of results be published as above, and if, in addition, the traces and hourly observations be preserved, as is suggested, future theorists would have a large and valuable source of information by which to test their speculations. I should be happy, had I the opportunity of using such a series, to discuss it after the manner that Sir E. Sabine has indicated in the very valuable papers which he has presented to the Royal Society.

No. 3.

Memorandum containing extracts from the Minutes of the Kew Committee relating to Magnetic Reductions, and containing also an estimate of the probable Expense of carrying out the list of suggestions (paper No. 2).

Kew Observatory,
4th March, 1870.

MY DEAR SIR,

In accordance with the wish expressed at the last Meeting of the Kew Committee for full information regarding the present state of the magnetic reductions, I beg to send you the following statement:—

The first extract bearing on this subject is one from the Report of the Kew Committee to the Aberdeen Meeting of the British Association. It is as follows:—

“As the staff of assistants at the Observatory is not sufficiently large to undertake these tabulations, General Sabine has undertaken to have the results tabulated at Woolwich for every hour.”

In a scheme for the working of the Observatory after it became the central Observatory of the Meteorological Committee, I suggested that it would be very desirable to undertake the tabulation and reduction of the magnetic curves.

Simultaneously with this scheme, their Report to be presented to the Meeting of the Association in 1867 was discussed by the Kew Committee, and in the Report the following statement occurs:—

“The magnetic curves produced at Kew previously to the month of January 1865 have all been measured and reduced, under the direction of General Sabine, by the staff of his office at Woolwich; and the results of this reduction have been communicated by General Sabine to the Royal Society in a series of interesting and valuable memoirs. It is now proposed that the task of tabulating and reducing these curves since the above date be performed by the staff at Kew working under the direction of Mr. Stewart.”

In accordance with this resolution, the magnetic tabulations were proceeded with as fast as the funds at the disposal of the Observatory would allow, and the exact progress made was from time to time reported to the Committee.

In my Report to the Meeting of the Kew Committee held on June 18, 1869, the following passage occurs:—

“In the present organization of the Observatory, it is the surplus funds that are devoted to magnetic reductions; but it will hardly be possible before the yearly accounts are closed to state the probable amount of the surplus.”

“It is, however, imagined that if the probable surplus for the year 1869–70 be anticipated and devoted to tabulation while the summer weather lasts, then before the end of next winter session the reductions will be very far advanced for all of the three magnetic elements.”

At the same Meeting the following resolution was passed:—

Resolved,—“That Mr. Balfour Stewart be authorized to apply the surplus funds in his hands to the tabulation and reduction of the magnetic

“ photographic records ; and that he be requested to have the work done
 “ with as much rapidity as is consistent with accuracy—the final reduction
 “ to include both monthly and annual means, but in the first instance the
 “ phenomena of the disturbances from 1863 to 1870 to be proceeded with.

“ In reference to Mr. Balfour Stewart’s proposal that a more intimate
 “ comparison between solar and magnetic records be made, it was resolved
 “ that he be requested to prepare such a comparison for one magnetic ele-
 “ ment, for a whole period of solar disturbance, for the consideration of the
 “ Committee.”

From all these extracts it will, I think, appear that the Committee considered that they would have funds sufficient to tabulate and reduce the magnetic curves since the beginning of 1865, the date at which Sir E. Sabine left off tabulating, and that any resolution having reference to curves of a previous date did not contemplate any retabulation of such curves. I conceive, therefore, that at present I am under obligation to tabulate and reduce the curves obtained since the beginning of 1865, the Committee acting on the supposition that the funds which accrue to the Observatory from various sources are sufficient for this purpose. If, however, the Committee should consider that, in addition to this, it would be desirable to systematize the whole Kew results after the method indicated in the suggestions by me which accompany this letter, it would be quite possible to accomplish this work before 1872, and to do so without materially interfering with the work of the Observatory ; but it would require additional funds for the purpose ; in fact, the question resolves itself into one of expense. The following estimate, prepared by Mr. Whipple, and revised by me, will give a tolerably good idea of the probable expense of doing this :—

	(e)	£	s.	d.
Purchase of two new Tabulating instruments and fittings		30	0	0
Measurement of curves to $\frac{1}{1000}$ of an inch from Jan. 1, 1858, to Dec. 31, 1864		143	14	0
Subsidiary measurements		63	0	0
Copying out and systematizing results		126	0	0
Extraction of disturbances		100	0	0
Paper and forms		10	0	0
		<hr/>		
		472	14	0
		<hr/>		

This sum would probably enable all these suggestions to be complied with, except those relating to the means connected with the lunar-diurnal variations. The production of such means since 1865 will, of course, form part of the reductions at present in hand, and it would be very easy to give the tables such a shape as to exhibit a classification according to the relative position of the sun and moon. If the results of this proved sufficiently valuable, the same classification might be afterwards extended to the results previous to 1865, provided the details of such results have been obtained and preserved by means of the outlay of £472 14s., as mentioned above. This particular form of reduction does not appear so pressing ; and as it would cost £130 to recast the individual results previous to 1865 into the precise form of lunar tables mentioned in the suggestions, this matter may be allowed to wait.

But the other matters mentioned in these suggestions are, I think, of greater importance, more especially as, in the very valuable paper of results produced by Sir E. Sabine, there would appear to have been contemplated an exhibition to the world of the most valuable and important facts derived from the Kew results, rather than an exhaustive reduction of the same (see paper No. 1). The Committee might, therefore, if the above outlay were incurred, exhibit the distribution over the various months of every year of the disturbed observations for the whole Kew series, and also exhibit the solar-diurnal variations of the horizontal and the vertical force.

If it be allowable to devote to this purpose £100 which I have in hand from the Royal Society, it would so far lessen the expense, and in this case £400 might be regarded as the extreme limit of what would be incurred.

I remain,

Yours very truly,

B. STEWART.

*J. P. Gassiot, Esq.,
Chairman of the Kew Committee.*

Extracts from Minutes of Kew Committee held at Burlington House on 9th March, 1870, Present Mr. Gassiot (in the Chair), Sir E. Sabine, Sir C. Wheatstone, Col. Strange, Dr. Miller, Mr. Galton, Mr. De La Rue, Mr. Spottiswoode.

“Resolved,—That the following work be executed at Kew, under the superintendence of Mr. Stewart.

“*Current Work.*

“The work as defined in paragraph marked (a), page lii (General Sabine’s Memorandum).

“*Arrears of Work.*

- “1st. Hourly tabulations from traces as defined in paragraph marked (b), page liii (Mr. Stewart’s statement).
 - “2nd. Separation of disturbances and solar-diurnal variations, paragraph (c), page liii.
 - “3rd. Secular change and semiannual inequality, paragraph (d), page liii.
- “These arrears to be executed in accordance with the estimate (e), page lv.”

It appearing that the only sum at the disposal of Mr. Stewart for back magnetic work was £100, Mr. Gassiot offered to supplement the difference required, provided the sum required from him did not exceed £400.

Resolved unanimously,—“That the Committee accept with thanks the munificent offer of their Chairman, and that Mr. Stewart be empowered to proceed with the work on the understanding that the total cost shall not exceed £500.”

Accounts of the Kew Committee of the British Association from August 18, 1869, to September 14, 1870.

RECEIPTS.

	£	s.	d.
Balance from last account	46	16	4
Received from the General Treasurer	600	0	0
For the verification of Meteorological Instruments:—			
From the Meteorological Office	69	9	0
From the Office of Standards	2	1	0
From Opticians and others	56	16	0
For the verification of Magnetical Instruments	128	6	0
For the construction of Standard Thermometers	5	10	0
From the Meteorological Office:—	20	0	0
Allowance for one year as one of the Observatories of the Meteorological Committee	250	0	0
Extra allowance to Kew as Central Observatory:—			
From October 1st, 1869, to March 31st, 1870, at £200 per annum	100	0	0
From April 1869 to 30th September 1870, at £400 per annum	200	0	0
For services of assistants	17	10	0
From sale of Photographic residues	567	10	0
Deficiency made up by the Chairman	4	17	1
	202	11	7
	<hr/>		
	£1575	11	0

PAYMENTS.

	£	s.	d.
Salaries, &c.:—			
To B. Stewart, four quarters, ending 30th September, 1870	200	0	0
Ditto, allowance for superintending work connected with the Meteorological Committee, from April 1st, 1870, to September 30th, 1870	100	0	0
Ditto, allowance for petty travelling expenses	10	0	0
G. Whipple, salary to quarter ending 30th September, 1870	125	0	0
T. Baker, do.	100	0	0
F. Page, do.	70	0	0
J. Rigby, do.	60	0	0
R. Beekley, salary from August 16th, 1869 to August 15th, 1870	130	0	0
J. Foster, salary from June 5th, 1869, to September 30th, 1870	51	11	0
A. Hill, salary from June 5th, 1869, to July 30th, 1870	28	12	0
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Apparatus, Materials, Tools, &c.	875	3	0
Ironmonger, Carpenter, and Mason	67	17	1
Printing, Stationery, Books, Postage, &c.	25	19	1
Gas and Coals	50	0	1
House Expenses, Chandlery, &c.	75	16	9
Porterage and petty expenses	71	9	6
Meteorological work done at extra hours	46	2	11
Magnetical tabulations done by supernumerary assistants	33	18	0
Rent of Land attached to Observatory	318	4	7
	11	0	0
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	£1575	11	0

Examined with the vouchers and found correct.

August 29th, 1870.

W. J. SMYTHE, Colonel.