PAPERS.

I. *Longitude of the Honourable East India Company's Observatory at Madras. By T. G. Taylor, Esq. F.R.S. and F.R.A.S.*

Read June 13, 1845.

An accurate determination of the longitude of the Madras Observatory is a want which, particularly of late years, has been duly acknowledged and felt, not only in an *astronomical*, but equally so in a *geographical* point of view; since, in the former case, any error in the value assumed in the comparison of the places of the moon and planets with the tables necessarily led to seriously mischievous results; and in a geographical point of view, the triangles in the great trigonometrical survey of India depend for their zero or point of departure upon the meridian passing through the Madras Observatory: the inquiry must, hence, be considered one of singular importance. On my arrival at Madras, in 1830, the determination of the longitude of the Madras Observatory by my predecessor (Mr. Goldingham), being deduced from no less than 230 observations of the eclipses of *Jupiter's* first and second satellites, and about 800 lunar distances, it appeared more than probable that its correction (if any were required) must necessarily be of very small amount; and, before a result derived from so large a number of observations could with safety be disputed, it was desirable to meet the inquiry with at least something like a corresponding number of observations: this, however, was a work of years to accomplish; hence the necessity of having recourse to some more satisfactory and expeditious method than that of eclipses.

On the erection of the present five-feet transit instrument, in 1831, without entertaining any serious hopes or expectations of amending the then received longitude, I commenced the observations of "Moon-culminating Stars;" and, computing from the observations of that year and the corresponding observations at Greenwich and Cambridge, the longitude came out $5^h\ 21^m\ 3^s{\cdot}7$, or about *five seconds of time less* than the value assigned by Mr. Goldingham.* To results thus obtained, however, I was then little inclined to give that degree of credit which later experience has shewn them to deserve; my reasons for doubt arose from considerations which it may not be improper I should here state. I had noticed that the diameter of the sun, as measured by different observers, was subject to considerable variation; if the same occurred with the moon, the determination of the longitude from the observations of the first limb *alone*, would necessarily be affected by a constant source of error, which repeated observation would not eliminate: it was probable, however, that the positive error — personal equation it may be termed — committed by an observer on the *first* limb, might be counterbalanced by a similar but *negative* error in the observation of the second limb; and the occurrence of this circumstance was indispensable to the accurate determination of the longitude. Whether such compensating effect does accurately take place, or whether observations of the moon are subject to the same extent of error as those of the sun,† must still remain among the matters of doubt; but, as far as the present observations go, it appears that discrepancies arising from this source are confined within rather narrow limits, inasmuch as the semidiameter of the moon, as measured at Madras, does not differ more than ($0''{\cdot}5$) half a second of space from that observed at Greenwich, Cambridge, Edinburgh, and Hamburg. In the early volumes of the *Madras Results*, it had been my practice to give the observations of the moon-culminating stars and eclipses of *Jupiter's* satellites, together with the longitude, as deduced therefrom, as far as circumstances would permit; but the extreme irregularity with which the corresponding Greenwich observations came to hand, rendered these results in some cases incomplete; and in the printing of Vols. IV. and V., not having received any of the Greenwich

* The longitude assigned by Mr. Goldingham was $5^h\ 21^m\ 8^s{\cdot}8$.

† The existing effect of the sun's rays, even when viewed through an appropriate dark glass, may, in the case of weak eyesight, occasion an ill-defined image of the limb, from which a stronger sighted observer would be free.

observations, the continuation of the series was necessarily interrupted. To supply this deficiency, however, Mr. RIDDLE (at the suggestion of Mr. BAILY) had undertaken the reduction of the corresponding moon-culminating stars for the years 1834–1837; and the results are given in Vol. XII. of the Society's *Memoirs*. In this paper, Mr. RIDDLE having at some length explained the particulars of the methods of computation employed, it will only be necessary for me here to refer to his paper, and to state, that the formula employed by him is precisely that which had been observed in obtaining the previous as well as the present results: there are one or two circumstances, however, in which I have differed from the practices observed by Mr. RIDDLE, which it may be as well here to explain. In cases in which the full moon has occurred in the interval between the moon's transiting the meridian of the Madras and the Western Observatory, it has sometimes happened that the first limb of the moon has been observed at Madras and the second limb at the Western Observatory; in these cases, Mr. RIDDLE has computed the sidereal time of the semidiameter passing the meridian from the semidiameter given in the *Nautical Almanac*, and deduced the longitude in the usual way. Fearing, however, that the semidiameter given in the *Nautical Almanac* might not represent the semidiameter due to observers at Madras or Greenwich, I have thought it better to reject the two or three observations in which this circumstance occurs. Again, in taking the means, Mr. RIDDLE has given to each result a weight equal to the number of stars observed, whereas I have made use of a table of weights depending upon the square root of the number of stars observed; the rapidity of change of the moon's right ascension $(t-\tau)$; and upon the relative accuracy of observations of the moon or stars. From the Madras Observations, I conclude that the mean error of any single observation of the moon is double that which may be expected from the observation of a star; hence, although the observation of several stars will eventually tend to produce accurate results, still it need not be expected that a result derived from several stars is necessarily very superior to another which may have been obtained from only one star.

In the paper by Mr. RIDDLE above alluded to, the few cases in which the second limb of the moon had been observed rendered it unnecessary that they should be separated from the far greater number of cases in which the first limb had been observed. On the present occasion, however, having succeeded in obtaining several observations of the moon's *second* limb, I have

thought it desirable to effect a separation, so as to exhibit the result from observations of the first limb distinct from that derived from the second limb, and in taking the means (neglecting the variable amount of $(t-\tau)$, which is not given in Mr. Riddle's paper), when one, two, three, or four stars have been observed, I have allowed the weights 5, 7, 8, and 9, respectively.*

With a view of presenting the whole of the observations and results in one view, as well as to correct those of Vols. I. and II. (in which I had not considered it necessary to pay attention to third differences in the interpolation of the moon's place), I have in the present paper given the recomputed results for 1831–1833; so that Mr. Riddle's paper, with the present one, exhibits each single determination from corresponding observations at Greenwich and Cambridge from 1831 down to the end of 1844,† and at Edinburgh from the commencement to the end of 1839. It only remains for me to advert to another series of observations which has now been introduced, namely, the observations made at the Hamburg Observatory—these having been taken from the *Astronomische Nachrichten*, Nos. 503, 504, and 508, with which I have been obligingly favoured from an unknown source; and, finally, to reduce each series to the meridian of Greenwich, the following differences of longitude have been employed:—

Cambridge — $0^{m}\ 23^{s}\cdot54$ (*Naut. Almanac*, 1845)
Edinburgh + 12 43·60 (*Naut. Almanac*, 1845)
Hamburg — 39 55·00 (*Conn. des Temps*, 1840).

* I have likewise corrected Mr. Riddle's paper for an error in the Madras Observation of the Moon on the 5th of October, 1835, thus:—

Column, Greenwich, 1835, October 5, *for* $45^{s}\cdot0$ *read* $58^{s}\cdot0$
—— Cambridge, 1835, October 5, — 38·0 — 51·0

† For the latter observations at Greenwich and Cambridge, I am indebted to the obliging attentions of the Astronomer Royal and Professor Challis.

These being applied to the means we get altogether as follows:—

Madras Observations compared with		☽'s First Limb.		☽'s Second Limb.	
		No. Obs.	Longitude.	No. Obs.	Longitude.
			h m s		h m s
For (1831–1833) (corrected)	Greenwich	10	5 20 52·88	1	5 20 65·20
	Cambridge	21	53·16	4	63.15
For (1834–1838) (See Vol. XII. R.A.S. *Mem.*)	Greenwich	49	55·01	5	59·74
	Cambridge	54	54·10	2	62·70
	Edinburgh	60	57·49	6	59·41
For (1838–1844)	Greenwich	78	57·56	36	57·21
	Cambridge	97	56·67	25	59·51
	Edinburgh	39	58·01	5	51·02
For (1838–1840)	Hamburg	34	57·58	2	51·89

Giving to each result a weight proportional to the number of observations we get

From 442 observations of ☽'s first limb .... 5 h 20 m 56·38 s with a probable error of ± 0·23 s
— 86 — — ☽'s second limb.. 58·19 — ± 0·57

Or, for the present, the most probable value for the longitude of the Madras Observatory, as resulting from the observations of moon-culminating stars, is

5 h 20 m 57·28 s

T. G. TAYLOR.

NOTE.

The above determination being less than that arrived at by the eclipses (as given by Mr. GOLDINGHAM), to the amount of eleven and a half seconds of time! I have been led to inquire what circumstances could possibly give rise to so large a discrepancy, and to which of the two methods it was chargeable. With regard to the method of moon-culminating stars, it seems to offer no permanent source of error where both limbs are observed; but the result from eclipses does not seem to be wholly free from objection, inasmuch as it appears (as far as my limited means of comparison permit) that the immersions of *Jupiter's* first satellite are seen *later* to the amount of *n* seconds, and the emersions *earlier* to the amount of $(n+10)$ seconds with a 5-feet achromatic by DOLLOND now in use, when compared with the 42-inch telescopes with which Mr. GOLDINGHAM's observations were made; this effect being increased in the case of the second satellite would nearly account for the total disagreement found.

Moon's First Limb at Madras and Greenwich.

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.
1831.	m s	s		1838.	m s	s	
Mar. 23	12 38·50	+54·06	26	May 7	10 9·67		
May 25	10 54·33	46·48	22		10 9·79	+54·85	25
June 20	10 34·60	52·27	22	June 2	9 39·82	68·28	19
Dec. 12	11 19·18	39·85	23	July 31	12 25·96	63·46	25
1832.				Sep. 3	12 50·45		
Mar. 13	13 29·85				12 50·19	52·72	33
	13 29·17	50·47	34	30	12 52·08		
April 13	11 29·66	58·86	25		12 51·95		
14	11 19·74	63·15	25		12 52·04	56·74	40
Oct. 8	11 2·81			Nov. 25	11 38·99	64·27	24
	11 2·63			Dec. 25	11 57·53	59·72	24
	11 2·69	57·80	34	28	14 16·15	55·14	28
Nov. 4	10 55·65	55·60	22	1839.			
29	10 52·53	47·05	22	Feb. 23	13 38·59		
1838.					13 38·97	52·46	34
Jan. 3	11 19·03	60·48	23	24	12 51·30	57·72	26
Feb. 2	12 24·71	57·60	25	Mar. 24	12 8·89	71·50	24
Mar. 6	12 4·64			April 25	9 32·41		
	12 4·95	82·00	30		9 32·54	41·59	24
9	10 6·02			26	9 40·31	55·63	19
	10 6·08	48·47	25	1840.			
10	9 44·04	31·04	19	Jan. 16	15 29·01	55·76	31
April 7	9 37·05	55·93	19	Feb. 12	14 57·09		
8	9 38·28	51·18	19		14 57·17		
9	9 53·63	45·33	20		14 57·17	44·54	46
May 2	10 31·60	63·30	22	13	14 51·81	57·82	30
3	9 58·72	69·10	20	April 11	11 27·21		
5	9 35·95				11 27·29		
	9 35·99	48·55	24		11 27·42	58·74	35
6	9 47·68			13	10 17·47		
	9 47·67				10 17·97	+44·67	26
	9 47·74	+49·76	30	15	10 12·51		

Moon's First Limb at Madras and Greenwich (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1840.	m s	s		1842.	m s	s	
April 15	10 12·34			Oct. 11	11 47·66	+79·35	24
	10 12·51			Dec. 14	12 3·62		
	10 12·32	+56·40	36		12 3·65		
Oct. 7	10 54·76				12 4·04	60·23	37
	10 54·78	51·69	28	1843. Feb. 13	12 15·85		
9	11 9·86				12 15·89	60·71	31
	11 9·62			April 8	12 44·90		
	11 9·60	50·83	34		12 44·82	62·10	33
1841. Jan. 5	15 53·44			10	12 27·49		
	15 53·59	56·16	40		12 27·81		
April 2	11 52·64	51·03	24		12 27·85		
3	11 26·49				12 27·71	56·81	43
	11 26·20	58·46	28	13	13 12·93		
May 26	12 17·23	69·20	25		13 12·95	51·70	34
1842. Jan. 26	13 56·30			May 13	14 29·54	56·57	29
	13 56·56	65·61	35	June 10	14 25·33		
Feb. 21	14 32·90	57·60	30		14 25·54	60·24	36
May 20	12 2·05	62·09	24	Oct. 4	10 28·21		
22	12 59·64				10 28·11	64·27	26
	12 59·18	79·72	33	5	9 10·82	62·07	19
June 21	13 18·02			Nov. 29	10 12·41	62·36	21
	13 17·45			1844. Jan. 28	11 25·74	50·46	23
	13 17·65	48·48	41	Mar. 3	12 8·92	48·50	24
Aug. 15	12 57·89			28	12 0·95	63·06	24
	12 57·93	62·70	33	29	11 57·35		
16	12 30·11	55·31	26		11 57·43	54·97	30
Sep. 13	12 6·13			30	11 57·98		
	12 6·16	52·81	30		11 58·32		
14	11 24·50				11 58·61	55·20	37
	11 24·50	67·86	28	April 1	12 25·84		
15	10 45·80	50·81	22		12 25·89	58·32	31
16	10 15·76	+39·15	21	2	12 55·08	+54·65	26

Moon's First Limb at Madras and Greenwich (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1844.	m s	s		1844.	m s	s	
April 28	11 57·47			Sept. 24	11 10·27		
	11 57·38	+65·00	30		11 10·19	+61·08	41
29	12 26·72			25	10 57·79	67·00	22
	12 26·61			Oct. 18	12 58·31	48·28	26
	12 26·61	69·55	38	22	10 52·13		
30	13 7·47				10 52·03		
	13 7·45	50·03	33		10 52·11	73·10	34
	13 55·97			25	11 2·79	59·04	22
May 1	13 55·97			Nov. 20	10 44·10		
	13 55·85	53·58	35		10 44·04	58 75	27
Sept. 20	13 23·23	+48·81	27	21	10 52·93	+54·13	22
24	11 10·16						

Moon's Second Limb at Madras and Greenwich.

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1831.	m s	s		1843.	m s	s	
Oct. 23	14 4·07	+65·20	28	May 13	14 30·40	+66·37	30
1838.				Oct. 14	12 21·96		
Feb. 9	10 29·46				12 22·16	62·50	31
	10 29·57	58·58	26	Nov. 8	11 58·17		
Mar. 11	9 34·46				11 58·17	59·71	30
	9 34·77	44·54	24	11	12 11·90	66·66	25
1842.				1844.			
May 24	13 32·89			Jan. 10	11 46·28		
	13 32·58	56·69	34		11 46·20	53·73	29
June 26	10 16·66	55·88	21	Mar. 5	12 30·71	56·48	25
Nov. 18	13 3·86	66·81	26	6	12 55·48		
Dec. 18	13 42·90	57·17	28		12 55·21	61·47	33
23	11 50·56	51·72	24	7	13 24·85	+53·09	27
1843.				April 3	13 32·26		
Feb. 16	12 38·78				13 32·21		
	12 38·75	62·77	32		13 32·45		
Mar. 17	13 23·39						
	13 23·48	+53·71	34				

Moon's Second Limb at Madras and Greenwich (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.
1844.	m s	s		1844.	m s	s	
April 3	13 32·60	+46·73	48	Sep. 30	11 34·71		
5	14 36·48				11 34·75	+73·24	36
	14 36·47			Oct. 3	11 43·30		
	14 36·25	68·43	45		11 43·73		
6	14 38·40				11 43·44	61·05	36
	14 38·28	24·00	37	26	11 17·26	58·84	23
8	13 35·49	66·64	28	27	11 30·74	52·45	24
May 2	14 41·28	54·21	30	28	11 39·75	42·37	24
8	11 38·23	47·03	24	31	11 30·78		
June 4	12 22·78	61·88	25		11 30·66	59·89	30
Aug. 4	10 58·09	60·40	22	Nov. 3	11 11·00	47·61	22
Sep. 28	11 9·59			26	11 42·45	53·24	24
	11 9·72	52·22	22	27	11 34·18		
29	11 22·64	+63·67	23		11 34·25	+73·67	30
30	11 34·89						

Moon's First Limb at Madras and Cambridge.

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\,20^m$.	Weight.
1831.	m s	s		1832.	m s	s	
Mar. 23	12 37·46	+27·38	26	Nov. 4	10 54·69	+27·75	22
May 25	10 53·41	20·33	22	1833.			
June 20	10 33·75	27·12	22	April 1	13 21·09	30·74	27
Oct. 17	11 50·47	29·62	24	28	13 6·98	28·81	26
Dec. 14	12 3·06	32·80	24	29	12 39·52	43·28	26
1832.				May 3	12 10·31		
Mar. 13	13 28·55	22·14	27		12 10·37	28·32	31
Sep. 4	11 41·18	51·36	24	June 29	12 14·89	31·51	25
5	11 35·73			July 1	12 23·72		
	11 35·84	20·45	30		12 23·54	54·02	31
Oct. 8	11 1·89			Sep. 26	10 26·12	20·28	21
	11 1·77	28·47	28	Oct. 20	11 57·63	+21·20	24
Nov. 1	11 6·20	+21·68	22	23	10 31·91		

Moon's First Limb at Madras and Cambridge (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1833.	m s	s		1838.	m s		
Oct. 23	10 31·86			April 7	9 36·19		
	10 31·95	+24·22	33		9 36·06	+22·88	34
Nov. 19	10 42·80			8	9 37·61		
	10 42·94	25·61	27		9 37·62		
1838.					9 37·51		
Jan. 3	11 18·26				9 37·57	27·20	34
	11 18·45						
	11 18·28	41·33	35	9	9 53·11		
					9 53·11		
4	11 30·76				9 53·27	30·10	31
	11 30·85						
	11 31·05			May 3	9 58·11		
	11 31·00	30·67	41		9 58·01		
					9 57·84	44·64	31
5	11 56·73			5	9 35·48		
	11 56·87				9 35·29		
	11 56·87				9 35·48	30·24	30
	11 56·81	24·70	42	7	10 13·88	22·29	21
Feb. 4	13 1·99			Aug. 2	14 21·53		
	13 1·65	38·66	33				
					14 21·76	29·41	36
8	11 9·55	27·22	23				
Mar. 6	12 3·65			Sep. 3	12 49·37		
	12 3·89	34·67	30		12 49·34	29·98	33
8	10 38·40			28	13 46·89		
	10 38·20				13 47·23		
	10 38·26	22·94	33		13 46·65	43·62	42
9	10 5·33			30	12 51·10		
	10 5·53				12 50·73		
	10 5·36	28·02	31		12 51·08	30·52	40
10	9 43·25			Nov. 1	13 14·28	18·58	27
	9 43·23			24	11 55·90	34·54	24
	9 43·05			Dec. 25	11 56·56		
	9 43·11	+37·95	34		11 56·34		
April 7	9 35·82				11 56·42		
	9 36·16				11 56·45	+30·54	42

Moon's First Limb at Madras and Cambridge (continued).

Date.	Observed Values of $(t-\sigma)$.	Longitude $5^h\,20^m$.	Weight.	Date.	Observed Values of $(t-\sigma)$.	Longitude $5^h\,20^m$.	Weight.
1838.	m s	s		1839.	m s	s	
Dec. 28	14 15·27			Oct. 16	12 18·51		
	14 14·94	+31·53	50		12 18·49		
1839.							
Feb. 21	14 2·89	40·54	49		12 18·47	+30·15	38
23	13 37·66			1840. Feb. 12	14 56·22		
	13 37·51				14 56·43		
	13 37·86	30·59	48		14 56·34	41·07	46
25	11 54·66			13	14 50·82	34·59	30
	11 54·16			14	14 10·04		
	11 54·33				14 10·22	44·74	36
	11 54·36	27·75	42	Mar. 13	13 11·93		
26	11 2·23				13 12·28	29·34	34
	11 2·49	33·34	28	April 10	12 24·11		
27	10 20·60				12 24·21	29·92	31
	10 20·75			11	11 26·48		
	10 20·38				11 26·40		
	10 20·51	36·85	36		11 26·38	34·37	35
Mar. 24	12 8·07			13	10 16·92		
	12 7·99				10 16·94		
	12 8·09	47·94	37		10 17·03	18·80	32
25	11 11·21			15	10 11·50		
	11 11·18				10 11·24		
	11 11·13				10 11·61		
	11 11·15	23·81	40		10 11·53	25·27	36
27	9 54·32			Oct. 7	10 54·17		
	9 54·28				10 54·09	33·86	28
	9 54·35	24·90	31	9	11 8·63		
April 25	9 31·93				11 8·57		
	9 31·77				11 8·66	19·96	34
	9 31·80	20·57	30	Dec. 3	10 42·63	25·70	22
28	10 32·76			6	13 33·42		
	10 32·90	32·27	27		13 33·62	+24·26	34
May 21	9 49·82	+32·04	20	1842. Feb. 21	14 31·42		

Moon's First Limb at Madras and Cambridge (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1842.	m s	s		1843.	m s	s	
Feb. 21	14 31·83	+40·80	37	April 12	12 45·36		
May 17	12 4·50	23·68	24		12 45·24	+34·80	32
June 20	13 17·00	16·90	27	May 13	14 28·64		
21	13 16·71	24·37	27		14 28·67		
July 20	12 24·12	35·39	25		14 28·64		
Aug. 15	12 56·83				14 28·66	37·09	50
	12 57·07			June 6	12 3·39	34·70	24
	12 57·06			10	14 24·47		
	12 56·82	36·44	45		14 24·62	37·77	36
16	12 29·53	39·88	25	Aug. 8	12 4·56	28·47	24
Sep. 14	11 23·53			Sep. 4	12 8·94	32·77	24
	11 23·34	37·29	29	Oct. 2	11 36·16		
15	10 45·16	31·72	22		11 36·33	32·09	30
16	10 14·93			4	10 27·25		
	10 15·22	33·24	26		10 27·21	35·75	27
Oct. 13	10 25·39			5	10 10·10	39·00	20
	10 25·55			Nov. 3	10 5·12	37·05	20
	10 25·43	35·47	32	4	10 17·48	37·90	27
Nov. 12	9 49·02			6	11 5·31	45·52	22
	9 48·79	51·16	25	28	10 31·57		
17	12 21·11				10 31·51	26·23	27
	12 21·20			29	10 11·78		
	12 21·15	23·66	38		10 11·72		
Dec. 14	12 2·82				10 11·55	35·00	32
	12 2·93			1844. Feb. 1	12 32·19		
	12 3·15	38·42	37		12 32·27		
17	13 49·10				12 32·23	37·19	39
	13 49·52	41·80	34	Mar. 1	12 15·63		
1843. Feb. 10	13 36·07				12 15·48	37·06	31
	13 36·01	35·41	34	2	12 10·13		
13	13 14·91				12 10·14	+33·39	31
	13 14·99	+37·55	34	28	11 59·79		

Moon's First Limb at Madras and Cambridge (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1844.	m s	s		1844.	m s	s	
Mar. 28	11 59·91			April 30	13 6·68	+30·00	33
	11 59·77	+32·59	37	May 1	13 55·03		
29	11 56·75				13 55·16	31·71	35
	11 56·62			July 27	14 10·13		
	11 56·59				14 10·19		
	11 56·65	35·12	42		14 10·02	38·56	44
30	11 57·48			Sep. 21	12 42·77		
	11 57·56				12 43·14	40·34	32
	11 57·76			24	11 9·43		
	11 57·53	36·19	42		11 9·37		
April 1	12 24·91				11 9·69		
	12 25·02				11 9·55	41·24	39
	12 24·87			25	10 56·94		
	12 25·12	33·92	43		10 57·14		
2	12 54·12				10 57·14	38·80	37
	12 54·36	33·54	33	Nov. 20	10 43·34		
29	12 25·48				10 43·38	37·83	27
	12 25·50			21	10 52·20	32·90	22
	12 25·51			23	11 22·93	32·27	23
	12 25·57	+33·42	43	Dec. 21	11 29·51	+24·84	23
30	13 6·60						

Moon's Second Limb at Madras and Cambridge.

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1831.	m s	s		1833.	m s		
Sep. 22	12 15·65			May 3	12 10·81		
	12 15·52	+38·42	31		12 10·87	+37·27	31
1832.				1838.			
Feb. 23	11 17·86	46·83	23	Feb. 9	10 28·62		
1833.							
Feb. 4	14 31·03	+37·73	30		10 28·66	+30·11	27

Moon's Second Limb at Madras and Cambridge (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 20^m$.	Weight.
1838.	m s	s		1843.	m s	s	
Mar. 11	9 33·91	+40·94	19	Feb. 15	12 40·23	+34·70	32
May 9	11 50·42	34·60	24	Mar. 17	13 22·37	28·29	27
Sep. 4	12 23·88			May 13	14 29·24		
	12 24·12	30·18	31		14 29·27		
1839.					14 29·24		
Feb. 27	10 20·29				14 29·26	39·27	50
	10 20·44			Nov. 7	11 33·22		
	10 20·07				11 33·16	30·15	30
	10 20·20	50·81	36	8	11 57·36		
28	9 51·40	34·94	20		11 57·39		
April 28	10 34·07				11 57·29	38·52	37
	10 34·21	46·19	27	1844.			
Sep. 23	12 11·03			Jan. 5	12 24·97		
	12 11·15	42·09	31		12 24·92	25·17	31
1840.				Mar. 5	12 29·82	33·64	25
Feb. 17	11 14·04			6	12 54·22		
	11 14·15	21·54	29		12 54·52		
1842.					12 54·29	36·27	40
May 24	13 32·01			April 3	13 31·11		
	13 31·69	35·93	34		13 31·24		
Oct. 19	11 4·02				13 31·43		
	11 4·27	44·59	28		13 31·48	21·91	48
Nov. 18	13 2·89			May 2	14 40·37	35·24	30
	13 2·86			Sep. 28	11 9·08		
	13 2·87	42·23	40		11 9·02		
1843.					11 9·10	48·15	34
Feb. 14	12 53·66			Nov. 26	11 41·75		
	12 53·97				11 41·70	+33·24	30
	12 54·07						
	12 54·06	+39·58	45				
15	12 40·09						

Moon's First Limb at Madras and Edinburgh.

Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 33^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $5^h\ 33^m$.	Weight.
1838.	m s	s		1838.	m s	s	
Jan. 4	11 59·27			May 5	9 59·04		
	11 59·44				9 58·96	+39·64	26
	11 59·62	+47·69	37	6	10 11·19		
5	12 26·28				10 11·16		
	12 26·53				10 11·49	43·96	31
	12 26·54			7	10 39·36		
	12 26·36	42·26	43		10 39·37	45·77	27
6	13 0·21			June 3	10 25·04		
	13 0·26	51·67	33		10 24·83	57·22	27
8	13 41·46			July 31	12 55·79		
	13 41·63				12 55·83	64·48	40
	13 41·53	43·19	42	Aug. 3	15 19·34		
Mar. 8	11 4·40				15 19·34	45·56	39
	11 4·32	22·18	28	Sep. 29	13 54·36		
9	10 29·80				13 54·21		
	10 29·98				13 54·53	57·57	43
	10 29·93	21·72	32	Oct. 1	12 59·55		
April 2	12 57·54				12 59·27		
	12 57·93				12 59·38		
	12 57·82	39·18	40		12 59·37	36·64	45
3	12 7·46	45·95	24	Nov. 1	13 47·50	49·37	28
5	10 39·58	31·42	22	Dec. 25	12 26·19		
6	10 12·72				12 26·11		
	10 12·76				12 26·17	53·03	38
	10 12·80			26	13 10·83		
	10 12·94	33·91	36		13 10·81	60·43	34
8	10 1·65			29	15 10·77	35·79	31
	10 1·62			1839. Jan. 26	14 44·56		
	10 1·49				14 44·57	+37·01	37
	10 1·74	+49·31	35	Feb. 22	14 38·83		

Moon's First Limb at Madras and Edinburgh (continued).

Date.	Observed Values of $(t-\pi)$.	Longitude $5^h\,33^m$.	Weight.	Date.	Observed Values of $(t-\pi)$.	Longitude $5^h\,33^m$.	Weight.
1839.	m s	s		1839.	m s	s	
Feb. 22	14 38·73			Mar. 23	13 39·40		
	14 38·91				13 39·13		
	14 38·94	+37·52	51		13 39·15	+36·94	42
23	14 11·09			24	12 37·45		
	14 10·89				12 37·64		
	14 11·26	53·44	44		12 37·79	42·23	39
24	13 21·57			25	11 38·83		
	13 21·78				11 38·74		
	13 21·68				11 38·73		
	13 21·51	28·38	47		11 38·84	28·92	41
25	12 23·36			29	9 58·19		
	12 23·40				9 58·29		
	12 23·31	19·51	38		9 58·24		
26	11 29·10	23·49	23		9 58·41	44·77	35
27	10 45·85			April 26	10 2·75		
	10 46·24				10 2·84	26·08	26
	10 45·71			27	10 24·63	41·35	21
	10 45·77	37·71	37	Oct. 17	12 28·87	51·08	25
Mar. 22	14 31·33			18	12 14·20	+54·06	25
	14 31·25	+39·42	37				

Moon's Second Limb at Madras and Edinburgh.

Date.	Observed Values of $(t-\pi)$.	Longitude $5^h\,33^m$.	Weight.	Date.	Observed Values of $(t-\pi)$.	Longitude $5^h\,33^m$.	Weight.
1838.	m s	s		1839.	m s	s	
Feb. 9	10 53·97			Feb. 28	10 15·06	+21·81	21
	10 54·05	+23·13	28	Mar. 30	10 9·58	42·22	20
Dec. 1	15 21·96			Sep. 23	12 40·51	+36·27	26
	15 21·65	+44·77	39				

Moon's First Limb at Madras and Hamburg.

Date.	Observed Values of $(t-\tau)$.	Longitude $4^h\,40^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $4^h\,40^m$.	Weight.
1838.	m s	s		1839.	m s	s	
May 5	8 24·33			Mar. 24	10 38·78		
	8 24·55				10 39·17	+59·61	31
	8 24·56	+63·95	30	25	9 48·99		
6	8 34·48				9 48·95		
	8 34·72	62·99	26		9 48·91		
7	8 57·67	49·87	21		9 48·99	53·80	40
June 2	8 27·51			26	9 9·48		
	8 27·68	73·52	25		9 9·11		
Sep. 3	11 15·05				9 9·54		
	11 15·08	60·83	33		9 9·20	59·12	36
27	12 12·98			April 28	9 14·20		
	12 12·84				9 14·49	60·92	27
	12 12·98	70·68	43	June 21	8 54·52	43·41	21
29	11 43·20			1840. Jan. 14	12 22·46	53·67	28
	11 43·14			15	13 13·35		
	11 42·85				13 13·09	69·16	38
	11 43·18	79·01	47	Feb. 12	13 5·58	66·93	30
30	11 16·37			Mar. 15	9 56·59		
	11 16·26				9 56·74	50·79	29
	11 16·45	60·73	40	April 10	10 53·44		
Nov. 25	10 12·10	67·90	24		10 53·52	65·33	31
27	10 27·80			13	9 1·28		
	10 27·50	59·04	30		9 1·29		
Dec. 29	12 47·26				9 1·27	53·82	32
	12 46·98			15	8 56·30		
	12 47·12				8 55·98		
	12 46·95	58·28	51		8 56·41		
1839. Jan. 23	11 23·68	68·64	24		8 56·22	64·91	36
Feb. 21	12 18·81			June 8	8 52·33	65·32	20
	12 18·92	70·56	35	Oct. 7	9 33·62	+64·05	22
Mar. 22	12 14·32	+61·78	28	Dec. 6	11 52·52		

Moon's First Limb at Madras and Hamburg (continued).

Date.	Observed Values of $(t-\tau)$.	Longitude, $4^h\ 40^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude, $4^h\ 40^m$.	Weight.
1840.	m s	s		1841.	m s		
Dec. 6	11 52·57	+60·86	34	Feb. 3	13 21·12		
1841.					13 21·15	+57·47	39
Jan. 2	10 56·59						
	10 56·74			4	12 38·36		
	10 56·77	78·92	39		12 38·81		
5	13 54·57	60·11	32		12 38·76	+56·15	44
Feb. 2	13 33·43	+61·81	31				

Moon's Second Limb at Madras and Hamburg.

Date.	Observed Values of $(t-\tau)$.	Longitude $4^h\ 40^m$.	Weight.	Date.	Observed Values of $(t-\tau)$.	Longitude $4^h\ 40^m$.	Weight.
1839.	m s	s		1840.	m s	s	
Mar. 30	8 33·33	+66·76	19	Feb. 17	9 51·78		
					9 51·88	+50·43	29

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