

Eclipses of the Satellites of Jupiter

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XXI. *Eclipses of the Satellites of Jupiter, observed by John Goldingham, Esq. F. R. S. and under his Superintendance, at Madras, in the East Indies.*

Read June 30, 1808.

THE following eclipses of the satellites of Jupiter, were observed with achromatic telescopes, by DOLLOND, of three and half feet focal length, and magnifying power between 70 and 80; having been constructed more immediately for this purpose, for which they were exceedingly well calculated in all respects.

An astronomical clock, with gridiron pendulum, and dead beat, regulated by transits of the sun and stars, was used for the time; which was deduced from the transit of the sun nearest the eclipse, and verified by the one immediately preceding or following.

The circumstances under which the eclipses were observed are noted; from these may be inferred, how far the results are to be depended upon: those observed with the "air clear and the planet high," are the most satisfactory and valuable, nothing to the contrary being afterwards expressed.

The longitude of the place, by numerous observations of various descriptions, is $5^h : 21' : 14''$ or $80^\circ : 18' : 30''$ east of Greenwich: by comparing this with the numbers in the last column, the difference of the tables will be obtained.

The greater number of these eclipses were not visible at Greenwich, but have been found very useful, when correspondent observations have been taken in India.

Persons not much in the habit of observing these eclipses, but desirous of obtaining as much correct information from their observations as possible, may find the following general remarks of use.

A correct difference of longitude, it would appear, is not to be expected, by comparing the time of observation with that in the tables; it therefore becomes necessary to have a correspondent observation to compare with, or some satisfactory observations taken under a known meridian, about the time; from which the errors of the tables may be found. Correspondent observations, should, however, be obtained if possible: but it must not be supposed, that even these will give a correct difference of longitude, unless observed at both places, under the like favourable circumstances, and with telescopes of the same powers.

The air being clear; the planet so high as to be out of the thick atmosphere, and to make the position easy; the telescope sheltered from the wind, and steady; neither moonlight nor twilight, and the satellite not near the body of the planet: An eclipse observed under such circumstances, will, I apprehend, be as perfect as it well can be; and a correspondent observation taken under the like circumstances, will give a correct difference of longitude of the two places, provided the eclipse be observed with telescopes of the same powers.

Taking the eclipses in the following tables, observed under these favourable circumstances as the standard, and comparing their results as given in the last column, with those

of the others, it will be found; how much the latter are affected, by the eclipses having been observed when the atmosphere was hazy, or the planet very low, during twilight, or when the moon was near the planet, or the satellite not far from the body of Jupiter; and that even if correspondent observations had been taken, under favourable circumstances, at a known meridian, the difference of longitude given by the comparison would have been far from correct: the same eclipse observed at two places, under similar unfavourable circumstances, would possibly give a result near the truth; as the observations at both places would be affected in the same way, but probably not in an equal degree, as it is not likely there would be exactly the same degree of haze, the same strength of twilight, &c. &c. at both places; and therefore those observations taken under the same *favourable* circumstances can only be relied upon with certainty.

It may not be an easy matter to have telescopes at both places of precisely the same powers for these observations: at Madras we had two telescopes in use, constructed at the same time, in appearance precisely alike, and intended by DOLLOND to have been so in all respects; yet on repeated trials, one was found to have a decided advantage of several seconds over the other, shewing the emersions sooner, and the immersions later by that quantity. In order to do away the error arising from a difference in the powers of telescopes, *immersions* and *emersions* should be observed at both places; the difference of longitude will be as much greater than it ought to be by one series as less by the other, but the medium will be the correct difference of longitude of the places: it is possible also there may be some difference in the eyes of

observers, any error which may arise from this source will also be done away by this method.

Hence it would appear, that in order to obtain a correct difference of longitude of two places from correspondent eclipses of the satellites of Jupiter, the circumstances at both places should be similar and favourable; and that the telescopes should have equal powers, or that both immersions and emersions should be observed, which indeed ought always to be done, where time will admit: also, that the circumstances being favourable at one place and not so at the other, a result very different from the truth will be obtained.

Eclipses of the Satellites of Jupiter.

Table I. First Satellite.

Day.	Im. or Em.	Time of Observation.						Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.		
		Apparent.			Mean.							
		h	'	"	h	'	"	h	'	"		
1794.												
Jan. 24	Im.	17	28	45	17	41	31	12	7	59	5 20 46	Planet clear and high, but near the D.
Feb. 9	Im.	15	41	24,5	15	56	4	10	20	55	5 20 29,5	Planet low and covered with a fog. Dark.
16	Im.	17	35	6	17	49	30	12	14	19	5 20 47	Clear. D bright, though distant from μ . Twilight.
Mar. 4	Im.	15	52	8,3	16	3	58,4	10	31	31	5 20 37,3	Clear, and the planet at a convenient altitude.
11	Im.	17	46	49	17	56	51	12	26	29	5 20 20	μ clear and high, but near \odot rise.
20	Im.	14	11	8,5	14	18	34,5	8	50	33	5 20 35,5	Planet rather low, and not very clear. The D bright.
27	Im.	16	6	27	16	11	41	10	46	1	5 20 26	Hazy. Planet high.
Apr. 5	Im.	12	30	24,5	12	32	58	7	10	19	5 20 5,5	Planet low, but clear.
12	Im.	14	26	4	14	26	39	9	5	41	5 20 23	Clear. The D up, but not very near μ .
19	Im.	16	21	8	16	19	59	11	0	54	5 20 14	Planet high, but covered with haze and near the D.
28	Im.	12	44	41,6	12	41	53,5	7	24	27	5 20 14,6	Planet high. Dark, but the atmosphere hazy.
May 5	Im.	14	38	47	14	35	10	9	18	53	5 19 54	Planet high, but covered with a thin haze.
12	Im.	16	33	14,3	16	29	16	11	13	2	5 20 12,3	Clear. Planet high.
21	Im.	12	55	24,5	12	51	36,2	7	35	11	5 20 13,5	Clear. μ high. The D up, but not bright or near μ .
28	Im.	14	48	46	14	45	41	9	28	37	5 20 9	μ high. A considerable undulation.
30	Im.	9	16	46,6	9	13	56	3	56	54	5 19 52,6	Planet rather low and misty.
June 4	Im.	15	41	41,3	16	39	40,7	11	21	44	5 19 57,3	Clear.
6	Im.	11	9	53	11	8	11	5	49	59	5 19 54	Clear. The D up, but not near μ .
July 1	Em.	7	58	0,5	8	1	25,2	2	37	22	5 20 38,5	Planet rather hazy; other circumstances favourable.
31	Em.	10	6	56,5	10	12	52,5	4	44	49	5 22 7,5	Planet high, but covered with haze.
Sep. 1	Em.	6	51	15	6	50	54	1	30	30	5 20 45	Planet high, but hazy, and near the D.
24	Em.	7	14	10	7	5	58,6	1	53	21	5 20 49	Clear. Dark. Planet high.
Oct. 17	Em.	7	36	18	7	21	38	2	15	4	5 21 14	Planet high, but rather hazy.
Nov. 9	Em.	7	51	50	7	35	55,5	2	30	51	5 20 59	Planet low, but clear. Dark.
25	Em.	6	7	25,5	5	54	51,5	0	46	11	5 21 14,5	Planet rather hazy. Twilight.
1795.												
Feb. 28	Im.	17	7	55,4	17	20	40	11	47	32	5 20 23,4	Planet covered with haze.
Apr. 8	Im.	15	42	12	15	43	55	10	21	47	5 20 25	Rather hazy. D up, and near the last quarter.
15	Im.	17	37	37	17	37	27	12	16	57	5 20 40	Clear. The planet high, but twilight.
24	Im.	14	1	13	13	59	9	8	40	28	5 20 45	Planet clear, though low. Dark.
May 1	Im.	15	55	38	15	52	28	10	34	54	5 20 44	Clear. μ high. The D up, but not near the planet.
10	Im.	12	16	54,5	2	13	0,5	6	57	21	5 19 33,5	Clear.
17	Im.	14	11	37	14	7	41	8	50	52	5 20 45	Planet high, but hazy.
24	Im.	16	4	31	16	1	1	10	43	57	5 20 34	Planet high and clear.
July 4	Im.	8	51	23,5	8	55	19,6	3	31	11	5 20 12,5	Planet low, near the D, and tremulous.
9	Im.	16	16	17,5	16	21	04	10	56	2	5 20 15,5	Planet high, but rather hazy, and the D up.
17	Im.	10	24	40	10	49	42	5	24	21	5 20 19	Planet high, and dark.
27	Em.	11	17	14,4	11	23	19,3	5	56	28	5 20 46,4	Clear, and the planet high. D up, and about 4 ^h from μ .
Aug. 12	Em.	9	37	38,5	9	42	16,5	4	16	33	5 21 5,5	Planet high and hazy. Dark.
26	Em.	13	31	55	13	33	21	8	10	13	5 21 42	Planet near the D, and covered with a thin haze.
28	Em.	7	58	59,5	8	00	55	2	39	34	5 20 25,5	Clear, but μ near the D.
Sep. 12	Em.	6	57	44,5	9	56	27,7	4	37	10	5 20 34,5	Clear. Dark. Planet high.
14	Em.	11	35	37,5	11	51	57,7	6	35	11	5 20 26,5	Clear. Dark.
27	Em.	10	21	32	10	12	21,5	5	1	1	5 20 31	Clear, but the D up, and near full.

Table I. First Satellite continued.

Day.	Im or Em.	Time of Observation.		Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.
		Apparent.	Mean.			
		h "	h ' "	h ' "	h ' "	
Oct. 6	Em.	6 49 10,5	6 37 14,5	1 28 27	5 20 43,5	Clear, and the planet high.
20	E.m.	10 44 7,5	10 28 58	5 23 23	5 20 44,5	Clear. Dark, but the planet low.
Dec. 14	E.m.	7 30 33	7 25 43,4	2 9 55	5 20 38	Planet low, but clear. Dark.
1796.						
Apr. 3	Im.	17 12 6	17 15 2	11 51 12	5 20 54	Planet rather hazy, and near the D.
26	Im.	17 26 56,3	17 29 31,2	12 6 11	5 20 45,3	Planet high and clear, but twilight.
May 12	Im.	15 43 29,3	15 39 32	10 22 59	5 20 30,3	Planet high, but hazy.
28	Im.	13 58 11,2	13 55 11	8 37 23	5 20 48,2	A thin haze over \mathcal{J} . The D near.
June 20	Im.	14 2 48	14 4 6,5	8 42 6	5 20 42	Planet high. A thin haze and moonlight.
July 6	Im.	12 15 38	12 20 4	6 54 52	5 20 46	Flying clouds. Dark. Planet high.
22	Im.	10 30 15	10 36 16,5	5 9 28	5 20 47	Planet low, but clear. A little tremulous. The D near \mathcal{J} .
29	Im.	12 24 15	12 30 15	7 3 33	5 20 42	Clear. Planet high.
Sep. 13	Em.	15 14 3,6	15 9 23,6	9 53 8	5 20 55,6	Planet rather low, but clear.
22	Em.	11 40 44,5	11 32 58,5	6 20 8	5 20 36,5	Planet high. Rather hazy.
Oct. 1	Em.	8 8 3,5	7 57 23	2 47 8	5 20 55,5	Clear, and the planet high.
15	Em.	12 2 43	11 48 19	6 41 59	5 20 44	Planet high. Thin clouds.
17	Em.	6 31 58	6 17 13	1 11 17	5 20 41	Clear. The planet sufficiently high.
31	Em.	10 25 1,5	10 8 47,3	5 4 15	5 20 46,5	Clear. Planet high.
Nov. 9	Em.	6 50 17,4	6 34 26	1 28 44	5 21 33,4	Planet high, covered by a thin cloud.
23	Em.	10 38 36	10 25 37	5 17 45	5 20 51	Clear. The planet moderately high.
Dec. 2	Em.	7 0 31,2	6 50 40	1 39 34	5 20 57,2	Clear. Planet high. D up, but far from \mathcal{J} .
1798.						
Jan. 6	Em.	6 46 41,2	6 53 13,5	1 25 58	5 20 43,2	Clear. Planet high.
13	Em.	8 40 23,4	8 40 46,6	3 19 8	5 21 15,4	Planet high, but hid by a cloud at the precise time of the emersion, and probably 15" afterwards.
29	Em.	6 56 37,3	7 10 17,7	1 35 51	5 20 46,3	Clear. Planet sufficiently high. D up, but far from \mathcal{J} .
Feb. 5	Em.	8 51 44,4	9 6 12,2	3 31 0	5 20 44,4	Planet rather low, but generally clear. Observation not satisfactory.
21	Em.	7 13 4,8	7 26 59,2	1 52 21	5 20 43,8	Planet high, but very tremulous and near the D.
Mar 16	Em.	7 36 34,5	7 45 16,3	2 13 36	5 22 58,5	Planet very low. Observation of little value in consequence.
June 12	Im.	17 31 21,5	17 30 53,5	12 11 23	5 19 58,5	Planet high. Rather hazy, about \odot rise.
Aug. 6	Im.	14 9 36,4	14 15 2	8 48 21	5 21 15,4	Clear. Planet high, but about 15° above the D.
Oct. 7	Im.	13 1 48	12 49 27	7 40 24	5 21 24	Planet high. Clear.
16	Im.	9 26 12,3	9 11 44,5	4 4 53	5 21 19,3	Planet sufficiently high. Clear.
21	Im.	16 52 22,4	16 36 59,3	11 31 16	5 21 6,4	Clear. Planet high.
23	Im.	11 21 24,2	11 5 46,6	6 0 2	5 21 22,2	Clear. Planet high D up, and near full.
30	Im.	13 15 58	12 59 45,6	7 54 41	5 21 17	Planet near the zenith. D up, but far from \mathcal{J} .
Nov. 15	Em.	13 39 55,5	13 24 55,4	8 18 28	5 21 27,5	Planet high. Clear. Observation not satisfactory to 10, or 15".
17	Em.	8 7 14	7 52 35	2 46 45	5 20 29	Clear. Planet high. D up, but far from \mathcal{J} .
24	Em.	10 0 3	9 47 13,5	4 39 32	5 20 31	Clear. Planet high. Moonlight.
Dec. 3	Em.	6 20 50	6 11 9,8	0 59 54	5 20 56	Planet high. A very thin cloud over the planet.
17	Em.	10 3 58,4	10 0 48,7	4 43 29	5 20 29,4	Clear. Planet near the zenith. Moonlight.
24	Em.	11 55 57,4	11 56 19	6 35 15	5 20 42,4	Planet high. Atmosphere somewhat hazy. Moonlight.
31	Em.	13 48 53,4	13 52 43	8 27 12	5 21 41,4	Planet low, and tremulous. Observation of little value.
1799.						
Jan. 9	Em.	10 7 57,2	10 15 43,5	4 47 37	5 20 20,2	Clear. Planet high.

Table I. First Satellite continued.

Day.	Im. or Em.	TIME OF OBSERVATION.			Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.
		Appar.	h	m			
Jan. 16	Em.	12 1 20	12 11 44.5	6 40 36	5 20 44	Planet rather low and tremulous.	
18	Em.	6 29 15.2	6 40 13.8	1 8 56	5 20 19.2	Planet high. D about 30° from ♃.	
25	Em.	8 23 10.5	8 56 01.5	3 2 42	5 20 28.5	Clear. Planet high.	
Feb. 1	Em.	10 17 45.5	10 31 49.5	4 57 10	5 20 35.5	Planet low, and covered with a thin haze.	
10	Em.	16 24 14.7	16 56 32.8	1 21 19	5 20 35.7	Planet high. Clear. Moonlight.	
17	Em.	8 38 1	8 52 21.6	3 17 27	5 20 34	Planet high. Clear. D up, but far from ♃.	
Aug. 2	Im.	15 42 16.1	15 48 5.7	10 22 31	5 19 45	♃ low and misty.	
Sep. 10	Im.	14 18 5.2	14 14 44.6	8 57 25	5 20 40.2	Planet high. Clear. D up, but opposite ♃.	
Oct. 3	Im.	14 34 57.6	14 23 49.6	9 14 1	5 20 56.6	Planet high. Clear.	
10	Im.	16 30 18.7	16 17 11.8	11 9 26	5 20 52.7	Planet high. Clear.	
Nov. 20	Im.	19 24 11.4	19 10 12.6	4 2 58	5 21 16	Clear. Planet high.	
Dec. 13	Im.	19 33 41.7	19 25 12.7	2 13 25	5 20 16.7	Planet rather low, but clear. Moonlight.	
13	Im.	9 24 39.2	9 19 23.6	4 4 11	5 20 28.2	Clear. ♃ high. Sat. close to ♃. D near full.	
22	Em.	15 51 13.7	15 55 21.8	2 33 42	5 22 31	Planet high, but hazy.	
27	Em.	15 18 12.3	15 20 00.6	9 56 46	5 21 26.3	Planet high, rather tremulous.	
29	Em.	9 45 42	9 48 22	4 24 29	5 21 13	Clear. Planet high.	
31	Second Satellite.						
1800.	Em.	7 12 27.6	7 16 03	1 49 40	5 22 47.6	Planet high and clear. D up. Observation not satisfactory.	
Jan. 5	Em.	11 36 33.2	11 42 54.4	6 15 42	5 21 13.2	Clear. Planet high. Moonlight.	
14	Em.	7 56 17.4	8 5 51	2 35 28	5 20 49.4	Clear. Planet high.	
21	Em.	9 48 44.5	10 0 33.6	4 28 3	5 20 41.5	Clear. Planet high.	
30	Em.	6 10 45	6 24 30	0 49 49	5 20 56	Planet high, rather hazy. Twilight.	
Feb. 6	Em.	8 14 47.5	8 19 12	2 44 8	5 20 33.5	Planet near the zenith. D up, uncertain to 6°.	
13	Em.	10 0 5	10 14 40	4 39 12	5 20 53	Planet high, rather hazy.	
Mar. 8	Em.	10 18 16.2	10 29 17	4 57 22	5 20 54.2	Planet high. D up.	
24	Em.	8 42 25	8 48 49.2	3 21 38	5 20 47	Clear. Planet high.	
Apr. 9	Em.	7 7 25	7 9 00.6	1 46 8	5 21 17	Planet high. D full, but opposite ♃.	
16	Em.	9 4 25	9 4 8.2	3 43 26	5 20 59	Planet rather low: tremulous. Dark.	
May 2	Em.	7 27 13	7 24 0	2 6 0	5 21 13	Planet rather low, somewhat hazy.	
25	Em.	7 45 0.4	7 41 32.5	2 20 53	5 24 7.4	Planet very low. A thick haze.	
30	Im.	14 28 9	14 17 15.4	9 7 37	5 20 32	Air clear. ♃ high. The object glass rather dimmed by the dew.	
1801.							
Jan. 15	Im.	14 27 29.3	14 37 25.1	9 4 58	5 22 31.3	Clear. Planet high.	
17	Im.	8 52 59.2	9 3 31.2	3 34 51	5 20 8.2	Clear. Planet high.	
24	Em.	13 1 22	13 13 56.3	7 39 57	5 21 25	Planet near the zenith. Position very awkward.	
26	Em.	7 28 47	7 41 45.7	2 8 4	5 20 43	Clear. Planet high. Moonlight.	
Feb. 2	Em.	9 21 17	9 35 17	4 1 4	5 20 13	Planet high. D just rising.	
9	Em.	11 15 8.6	11 29 45.3	5 54 52	5 20 16.6	Planet near the zenith. Clear.	
18	Em.	7 38 22	7 52 41	2 18 8	5 20 14	Planet high. D up, but far from ♃.	
23	Em.	15 6 34.3	15 20 15.3	9 44 38	5 21 56.3	Planet very low and tremulous.	
25	Em.	9 33 28.6	9 46 53.1	4 13 34	5 19 54.6	Moonlight. Planet near the zenith.	
Mar. 4	Em.	11 29 51.3	11 41 52	6 9 39	5 20 12.3	Clear. Planet high. D up, but far from ♃.	
6	Em.	5 59 38.5	6 11 14.5	0 38 42	5 20 56.5	Planet high. Somewhat hazy. Twilight.	
11	Em.	13 26 18	13 36 33	8 6 6	5 20 12	Planet rather low and tremulous.	
13	Em.	7 55 37.4	8 5 23.2	2 35 14	5 20 23.4	Clear. Planet high.	

Table I. First Satellite continued.

Day.	Im. or Em.	Time of Observation.				Time by the Ephemeris.	Longitude of Madras by the Tables.			Circumstances of Weather, &c.		
		Apparent.		Mean.			h	'	"			
		h	'	"	h	'	"	h	'	"		
Mar. 27	Em.	11	49	49,6	11	55	20,2	6	29	6	5 20 43,6	Planet rather low, but clear.
29	Em.	6	18	52,7	6	23	50,3	0	58	21	5 20 31,7	Clear. Planet high. Twilight.
Apr. 5	Em.	8	15	48	8	18	35,5	2	55	23	5 20 25	Planet high. Rather hazy.
12	Em.	10	15	37	10	16	24,8	4	52	19	5 23 18	Clear. ♃ high. The observation not satisfactory.
28	Em.	8	35	44,4	8	32	25,3	3	14	24	5 20 40,4	Planet high, but hazy.
May 21	Em.	8	49	53,4	8	46	6	3	29	8	5 20 45,4	Clear, and planet high. The D up.
Nov. 3	Im.	15	32	11	15	15	56,5	10	13	43	5 18 28	Planet high. A thin haze.
19	Im.	13	47	38	13	33	19,3	8	27	15	5 20 23	Planet low and tremulous.
26	Im.	15	34	46	15	22	25	10	18	49	5 15 57	Planet high, but covered with a thick haze.
Dec. 3	Im.	17	30	6	17	20	20,3	12	9	36	5 20 30	Clear. ♃ in the zenith. Twilight just appearing.
26	Im.	17	27	59	17	29	5,7	12	7	24	5 20 35	Clear. ♃ high, but near the D. Twilight beginning.
1802.												
Jan. 18	Im.	17	27	0	17	37	53,8	12	6	16	5 20 44	Planet high. Rather hazy. D up. Twilight.
Feb. 5	Im.	10	7	25	10	21	50	4	46	55	5 20 30	Clear. Planet high.
19	Im.	13	54	59,2	14	9	11,7	8	34	38	5 20 21,2	Clear. Planet high. D near ♃.
28	Em.	12	34	10,3	12	47	10,5	7	13	30	5 20 40,3	Clear. Planet high.
Mar. 7	Em.	14	29	11	14	40	31,6	9	9	9	5 20 2	Planet high. Clear.
9	Em.	8	58	17	9	9	11	3	38	6	5 20 11	Clear. Planet high.
16	Em.	10	54	22,7	11	3	20,4	5	34	14	5 20 8,7	Clear. Planet high. D near ♃, and almost full.
Apr. 8	Em.	11	14	37,5	11	16	36,7	5	52	55	5 21 42,5	Planet high. Hazy.
17	Em.	7	38	34,4	7	38	11	2	18	24	5 20 10,4	Clear. ♃ in the zenith. D rising.
June 25	Em.	8	15	23,4	8	17	23,4	2	53	9	5 22 4	Planet high, but misty. Telescope not steady.
Oct. 30	Im.	16	34	29	16	17	19,5	11	13	57	5 20 32	Planet rather low and tremulous. Air clear.
Nov. 22	Im.	16	41	31	16	27	55	11	20	55	5 20 36	Planet rather low, but clear.
Dec. 15	Im.	16	45	48,6	16	41	18,6	11	20	55	5 24 33,6	Clear. ♃ near the D. Uncertain observation.
31	Im.	14	48	44,6	14	52	9,6	9	28	22	5 20 22,6	Clear. Planet high.

Table II. Second Satellite.

Day.	Im. or Em.	Time of Observation.		Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.
		Apparent.	Mean.			
		h ' "	h ' "	h ' "	h ' "	
1794.						
Feb. 27	Im.	15 17 10	15 30 5	9 58 37	5 18 33	Planet low, and covered with haze.
Mar. 31	Im.	15 4 40,3	15 8 42	9 45 14	5 19 26,3	Clear. Planet high.
Apr. 7	Im.	17 41 2,5	17 42' 57,7	12 22 3	5 18 59,5	Clear. Planet high. Near ☉ rise.
25	Im.	12 10 53	12 8 34	6 52 17	5 18 36	Clouds covered the planet, after the satellite had faded, probably a very few seconds before it immersed.
May 2	Im.	14 47 27	14 44 13,5	9 27 32	5 19 55	Planet near the meridian, but very tremulous.
9	Im.	17 22 6	17 18 13,5	12 2 11	5 19 55	Clear. Planet high. Strong twilight.
27	Im.	11 46 43,3	11 43 30,3	6 26 38	5 20 5,3	Clear. Planet high. Dark.
June 3	Im.	14 20 13	14 18 1	8 59 41	5 20 32	Clear. Planet high. Dark.
10	Im.	16 52 37	16 51 43	11 32 26	5 20 11	Clear, but γ rather low. Beginning of the twilight.
21	Em.	11 21 7	11 22 29	6 0 51	5 20 16	Clear. Planet high. Satellite emerged close to the planet.
July 16	Em.	8 17 13,6	8 22 49,5	2 57 8	5 20 5,6	Planet high. Very little hazy.
Aug. 17	Em.	7 56 1,6	7 59 39,5	2 35 54	5 20 7,6	Planet high. Clear. Dark.
24	Em.	10 33 19,4	10 35 15	5 12 43	5 20 36,4	Planet high. Very thin haze. Dark.
Oct. 20	Em.	7 36 1	7 20 49,5	2 14 43	5 21 18	Clear. Dark.
1795.						
Apr. 1	Im.	16 34 57,5	16 38 44	11 16 1	5 18 56,5	Clear. Dark. Planet sufficiently high.
May 3	Im.	16 26 50	16 23 26	11 6 28	5 20 22	Hazy. Planet high. γ up, but far from γ .
28	Im.	13 32 6	13 29 1	8 11 48	5 20 18	Planet high. Rather hazy. The γ up, but far from γ .
Aug. 11	Em.	7 24 42	7 29 27,5	2 4 26	5 20 16	Clear. Dark. Wind high.
18	Em.	10 1 18,4	10 4 47	4 41 8	5 20 10,4	Clear. γ high. Dark.
Sep. 12	Em.	7 12 28	7 8 31,5	1 52 13	5 20 15	Clear. Planet high. Dark.
Oct. 14	Em.	7 2 32	6 48 33,5	1 41 15	5 21 17	Clear. γ high.
Nov. 15	Em.	6 44 31	6 29 24	1 23 13	5 21 18	Clear. The γ up.
1796.						
Apr. 26	Im.	15 41 47,5	15 39 13,5	10 20 47	5 21 00,5	Planet low and tremulous. The γ up.
May 28	Im.	15 29 9	15 26 9	10 8 21	5 20 48	Hazy. Planet high. The γ near γ .
July 24	Im.	12 15 26	12 21 30	6 54 58	5 20 28	Planet high. Somewhat hazy. The γ near γ .
Aug. 25	Im.	12 5 16	12 6 46	6 44 28	5 20 48	Planet high. Clear. Satellite close to the planet.
Sept. 12	Em.	9 31 34	9 27 20	4 10 55	5 20 39	Planet high. A thin haze.
19	Em.	12 10 3	12 3 19	6 49 40	5 20 23	Clear. Planet high.
26	Em.	14 48 48	14 39 38,5	9 28 20	5 20 28	Planet low and tremulous.
Oct. 14	Em.	9 24 50,5	9 10 40,7	4 3 34	5 21 16,5	Planet covered at the time by a very thin cloud.
21	Em.	12 1 22	11 45 55	6 40 56	5 20 26	Planet sufficiently high.
Nov. 15	Em.	9 7 33	8 52 36	3 46 19	5 21 14	Planet high. A thin haze. γ up, but not near γ .
1798.						
Jan. 12	Em.	7 59 23,3	8 8 23,3	2 38 21	5 21 2,3	Flying clouds. Planet high.
Mar. 17	Em.	7 22 34	7 30 58,5	2 0 5	5 22 29	Planet very low and tremulous.
June 24	Im.	17 21 19	17 23 25,3	11 58 24	5 22 55	Planet high. Somewhat hazy. Twilight.
Sep. 28	Im.	16 51 32	16 41 51,6	11 30 2	5 21 30	Planet high. Hazy. The γ near γ .
Oct. 9	Im.	8 51 1,5	8 38 11,2	3 29 35	5 21 26,5	Clear. γ low, and rather tremulous.
23	Im.	14 9 2	13 53 23,5	8 47 39	5 21 23	Planet near the zenith. Moonlight.
Nov. 17	Em.	13 45 18	13 30 42	8 22 26	5 22 52	Clear. Planet high.
Dec. 12	Em.	10 47 12,5	10 41 37,7	5 25 34	5 21 38,5	Planet high. Clear.

Table II. Second Satellite continued.

Day.	Im. or Ern.	Time of Observation.		Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.
		Apparent.	Mean.			
		h ' "	h ' "	h ' "	h ' "	
1799.						
Jan. 6	Em.	7 45 58,2	7 52 25,6	2 25 8	5 20 50,2	Planet high. Clear.
13	Em.	10 20 13	10 29 33	4 59 34	5 20 39	Planet high. D near ♃.
Feb. 7	Em.	7 25 0,2	7 39 33,9	2 3 49	5 21 11,2	Planet high, rather hazy.
14	Em.	10 1 25,6	10 15 58	4 40 28	5 20 57,6	Planet low and tremulous. D up.
Mar. 11	Em.	7 12 30	7 22 41,3	1 51 40	5 20 50	Clear. Planet high. Moonlight.
July 20	Im.	16 42 6,7	16 48 2,8	11 20 43	5 21 23,7	Planet high. Hazy. Observation uncertain.
Sep. 15	Im.	13 35 42,6	13 30 37,6	8 14 34	5 21 8,6	Planet rather low. Hazy. D up, and near the full.
Oct. 17	Im.	13 28 32	13 13 52,3	8 6 55	5 21 37	♃ high. Clouds after the satellite had faded, possibly 15 or 20" before the time. D up.
24	Im.	16 6 7,2	15 50 22	10 44 29	5 21 38,2	Planet near the zenith. D up.
Nov. 18	Im.	13 13 3,4	12 58 35,8	7 51 54	5 21 9,4	Planet near the zenith. D up. Observation uncertain to 10"
Dec. 6	Im.	7 35 25,6	7 30 56,8	2 18 47	5 20 38,6	Planet rather low, but clear. Moonlight.
13	Em.	10 18 49	10 5 34,4	4 53 1	5 17 48	♃ high, and the D near. Clouds covered the planet after the satellite had faded, possibly 30 or 40" before the time. Observation of no value in consequence.
1800.						
Jan. 7	Em.	9 46 30	9 53 19,6	4 24 31	5 21 59	Planet high. Clear. D near ♃.
Feb. 8	Em.	9 28 35	9 43 10,8	4 7 49	5 20 46	Planet high. D near ♃.
Mar. 12	Em.	9 22 44,5	9 32 42	4 1 54	5 20 50,5	Planet high. D up, but far from ♃. Rather hazy.
Nov. 19	Im.	14 45 36,5	14 31 15	9 24 1	5 21 29,5	Clear. Planet high.
26	Im.	17 18 36,7	17 6 22	11 57 16	5 21 20,7	Planet near the zenith. Twilight.
Dec. 14	Im.	11 40 37	11 35 45,7	6 19 1	5 21 36	Clear. Planet sufficiently high.
1801.						
Feb. 2	Em.	8 26 3,4	8 40 10,6	3 3 53	5 22 10,4	Clear. Planet. Observation not satisfactory.
9	Em.	11 2 30	11 17 6,7	5 40 56	5 21 34	Clear. Planet near the zenith. Observation not satisfactory.
Mar. 6	Em.	8 17 9,3	8 28 44	2 56 17	5 20 52,3	Clear. ♃ near the zenith.
13	Em.	10 56 45,6	11 6 29,3	5 36 1	5 20 44,6	Planet near the zenith. Clear.
20	Em.	13 37 10,2	13 44 49,3	8 15 58	5 21 12,2	Planet very low, and tremulous.
Oct. 19	Im.	16 46 35	16 31 38	11 26 19	5 20 16	Clear. Planet high. Twilight.
Dec. 15	Im.	13 3 19,2	12 58 53,1	7 42 10	5 21 9,2	Clear. Planet high.
29	Im.	18 4 18,6	18 6 54,6	12 43 1	5 21 17,6	Clear. Planet high. Twilight.
1802.						
Jan. 9	Im.	9 50 27,5	9 57 56,3	4 29 37	5 20 50,5	♃ rather low and tremulous.
23	Im.	14 55 7,7	15 7 24,3	9 34 30	5 20 37,7	♃ in the zenith. Clear. Moonlight. The object glass dimmed by dew.
Feb. 10	Im.	9 21 39,5	9 36 18	4 0 48	5 20 51,5	Clear. Planet high. Moonlight.
17	Im.	11 56 50	12 11 13,8	6 36 58	5 19 52	Planet near the zenith. D full, and very close to ♃.
Mar. 7	Em.	9 22 13,3	9 33 37	4 1 17	5 20 56,3	Planet high. Clear. Observation good.
May 17	Em.	11 50 57,3	11 46 59,4	6 29 10	5 21 47,3	♃ low. Hazy. D up.

Table III. Third Satellite.

Day.	Im. or Em.	Time of Observation.						Time by the Ephemeris.	Longitude of Madras by the Tables.	Circumstances of Weather, &c.				
		Apparent.			Mean.									
		h	'	"	h	'	"	h	'	"				
1794.														
Feb. 15	Im.	15	57	20,5	16	11	49	10	36	42	5	20	38,5	Planet clear and high. D near full, but far from \mathcal{J} .
Mar. 30	Im.	15	53	1,5	15	57	21	10	31	52	5	21	9,5	Planet dimmed in a small degree by vapour.
May 5	Im.	11	50	39	11	47	3	6	29	4	5	21	35	Hazy. Planet rather low. Dark.
	Em.	14	36	56	14	33	19,5	9	16	38	5	20	18	Planet high. A thin haze. Dark.
	Im.	15	49	10	15	45	12	10	27	30	5	21	40	Clear. Planet high.
July 23	Im.	7	25	59	7	32	0	2	6	32	5	19	27	Clear. Planet high. The satellite close to \mathcal{J} .
Sep. 4	Im.	7	33	32	7	32	13	2	13	15	5	20	17	Rather hazy. Planet high. The D near.
1795.														
May 27	Em.	14	38	43	14	35	31	9	17	4	5	21	39	Clear. Planet high.
July 16	Im.	14	58	24	15	4	01,5	9	34	45	5	23	39	Clear. Planet high. Dark.
Aug. 14	Em.	10	31	33	10	35	49,5	5	10	24	5	21	9	Clear. Planet high. Dark.
Sep. 26	Im.	7	19	8	7	10	20	1	57	2	5	22	6	Planet high. Air not very clear. The D up.
Nov. 1	Em.	7	8	9	6	54	54	1	45	50	5	22	19	Clear. Planet high.
	Im.	7	36	28	7	20	26	2	13	13	5	23	15	Clear. Dark.
Dec. 14	Em.	7	5	44	7	0	54	1	43	6	5	22	38	Clear. Dark.
1796.														
May 12	Im.	15	41	59,5	15	38	2	10	20	16	5	21	43,5	Hazy. Planet high.
Oct. 10	Em.	7	24	19	7	11	06,7	1	59	28	5	24	51	Hazy. Planet high. The D up, but not near \mathcal{J} .
Nov. 22	Em.	7	35	8	7	21	49	2	9	44	5	25	24	Planet high. Rather hazy.
1798.														
Jan. 26	Em.	7	55	14,3	8	8	22	2	31	29	5	23	45,3	Clear. Planet high. The D up, but far from \mathcal{J} .
Sep. 5	Em.	12	39	6	12	37	22,6	7	15	54	5	23	12	Clear. Planet high.
	Em.	16	42	40	16	38	30,5	11	18	35	5	24	5	Clear. \mathcal{J} near the zenith.
Oct. 18	Im.	11	6	49,5	10	51	58	5	38	47	5	28	2,5	Clear. \mathcal{J} high. Moonlight.
	Em.	12	56	22	12	41	29,5	7	30	52	5	25	30	Clear. \mathcal{J} near the zenith. Observation uncertain to 15 or 20. ^h
	Em.	16	59	44	16	43	51,3	11	32	30	5	27	14	Clear. \mathcal{J} high and near the D. The satellite close to \mathcal{J} .
1799.														
Jan. 5	Im.	6	52	56	6	58	5,3	1	26	0	5	26	5,6	Clear. Planet high. }
	Em.	8	48	27	8	54	29,5	3	25	25	5	23	2	Clear. Planet high. }
	Im.	10	50	21,4	10	59	19,3	5	24	18	5	26	3,4	Clear. Planet high.
Apr. 1	Im.	7	9	23	7	13	15	1	44	1	5	25	22	Clear. Planet high.
Oct. 4	Im.	15	17	57	15	6	30,5	9	53	43	5	24	14	Planet high. Clear.
1800.														
Jan. 27	Em.	9	34	4	9	47	18,5	4	12	43	5	21	21	D near the zenith. Clear.
1801.														
Jan. 13	Im.	10	3	45,7	10	12	54	4	44	14	5	19	31,7	Planet high. Clear.
1802.														
Feb. 4	Im.	8	54	56	9	9	15,4	3	38	7	5	16	49	Clear. Planet high.
Nov. 3	Im.	16	42	7	16	25	52,8	11	26	39	5	15	28	Air clear, but \mathcal{J} rather low.