IX. *On the Lunar Atmospheric Tide at Singapore.*

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At the commencement of the year 1847, a paper by Colonel Sabine, R.A., V.P.R.S., was read before the Royal Society on the Lunar Atmospheric Tide at St. Helena. The influence of the moon upon the barometer, although small in amount, was shown in a very striking and decided manner; for after eliminating the regular diurnal variation, the differences arranged in lunar tables showed a decided maximum, both at the superior and inferior culmination of the moon, and a decided minimum at its rising and setting.

The effect which the moon's position, relatively to the meridian of the place, had upon the barometric pressure, was publicly noticed, about the middle of 1842, by Captain Lefroy, R.A., who appears to have had his attention directed to it from the first establishment of the observatory at St. Helena.

On the receipt of Colonel Sabine's paper, I was anxious to ascertain if the fact of the moon's influence, so clearly and decidedly shown at St. Helena, could be similarly proved by the Singapore barometric observations.

I therefore determined, before leaving England for India, to proceed upon the plan adopted by Colonel Sabine, and in order that a comparison might be made between the results at Singapore and at St. Helena, have copied to a considerable extent the form of the different lunar tables drawn up by him in his very valuable paper.

The observatory at Singapore was in latitude 1° 18′ 32″ north, and longitude 103° 56′ 30″ east of Greenwich. The cistern of the barometer was a few feet above high-water mark: the barometer was made by Newman: the diameter of the tube =0·532 inch. The observations of the barometer, by my assistants, were made at every two hours during the whole of 1841, the early part of 1842, and that of 1843; during the rest of the time, to the close of 1845, at every hour.

In making out the Tables, showing the moon's effect upon the barometer, I have only taken complete astronomical days, from noon to noon; and as Sundays were omitted, and as the observations commenced at midnight on Sunday and terminated at 11 P.M. on Saturday, the broken portions of Monday and of Saturday have not been taken into consideration; the mean, however, of the entire month has been assumed to be identical with the mean of these complete days.

The Barometer Tables, corrected to 32°, having been made out, the mean monthly

height of the barometer at each hour was deducted from the height given by observation at the corresponding hours during the month; if the height of the barometer, at any hour of observation, was less than the mean height at that hour, the difference was put down with the sign −; if greater, with the sign +. By this process the diurnal variation was eliminated. The residual quantities were then arranged in Tables, and the observation corresponding the nearest in time to the moon's culmination being marked for each day, the whole were again re-arranged in lunar tables as follows:—

The moon's superior culmination was assumed as 0 hour of lunar time, and the differences corresponding to that hour placed in the first column; the remaining columns were similarly formed.

The means of the sums of these differences are exhibited in Table I., which consists of two parts, the first part containing the barometric differences at the lunar hours from the superior to the inferior passage, and the second part, from the inferior to the superior passage; the means for each period of six months are shown in the final column of the second part of the Table.

Table II. shows the differences between the mean results and the several numbers in Table I. It must be borne in mind, that had the sets of weekly observations been complete, the sum of the minus differences would have equalled the plus ones: this, however, is not the case owing to the omissions above noted, and an inequality is thereby produced which occasioned the formation of Table I., in which the range of the mean values is shown, the lowest number being assumed as zero.

The means of the complete years 1841, 1844 and 1845, are shown in Table III.; and as two-hourly observations were taken during the first six months of 1842 and of 1843*, and hourly observations during the latter portions of those years, the results of the first six months of 1842 have been combined with the first six months of 1843, and the hourly observations of the latter halves of these years have been combined for the same reason.

In Table IV. the whole of the two-hourly observations, for a period of twenty-four months, have been added together for a general mean, and similarly the whole of the hourly observations for a period of thirty-six months. The results are exhibited in Plate X., which is drawn to ·001 of barometric pressure to 0·74 of an inch of scale.

Finally, Table V. exhibits the observations of three years combined, so as to show the effect upon the barometer of the moon when similarly situated both in its superior and inferior passage; and in a column in juxtaposition is placed a similar table derived from two years' observation at St. Helena, extracted from Colonel Sabine's valuable paper on the subject; from which it will be observed that the effect produced by the moon upon the barometer at Singapore, in the vicinity of the Equator, is slightly greater than at St. Helena, more distant by $14\frac{1}{2}$ degrees of latitude.

* In 1843, in consequence of a deficiency in the number of assistants,

With respect to the oceanic tide, the difference between rise and fall at spring tides varies from 9 to 12 feet. The establishment of the port is about $10^h\ 50^m$ A.M.

TABLE I.

Mean Barometrical Differences at the several Lunar Hours.

1st Part. From the Superior to the Inferior Passage.

	Mean of each of the Lunar Hours.											
	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
First part of 1841	·00603		·00540		·00107		·00077		·00176		·00332	
Second part of 1841	·00619		·00442		·00293		·00184		·00369		·00445	
First part of 1842	·00599		·00470		·00214		·00275		·00000		·00264	
Second part of 1842	·00796	·00685	·00568	·00473	·00315	·00085	·00061	·00000	·00109	·00326	·00355	·00625
First part of 1843	·00372		·00411		·00191		·00201		·00311		·00369	
Second part of 1843	·00728	·00612	·00502	·00391	·00365	·00135	·00000	·00129	·00138	·00324	·00199	·00278
First part of 1844	·00551	·00533	·00405	·00376	·00304	·00050	·00000	·00030	·00141	·00365	·00500	·00739
Second part of 1844	·00882	·00827	·00702	·00641	·00390	·00173	·00004	·00064	·00128	·00215	·00279	·00351
First part of 1845	·00674	·00440	·00253	·00150	·00113	·00000	·00100	·00025	·00114	·00277	·00305	·00422
Second part of 1845	·00774	·00829	·00611	·00571	·00280	·00199	·00024	·00015	·00161	·00341	·00411	·00526

2nd Part. From the Inferior to the Superior Passage.

	Mean of each of the Lunar Hours.												Mean in the six months.
	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	
First part of 1841	·00468		·00500		·00259		·00069		·00000		·00397		·00294
Second part of 1841	·00723		·00594		·00113		·00000		·00097		·00405		·00358
First part of 1842	·00431		·00552		·00286		·00178		·00092		·00490		·00321
Second part of 1842	·00807	·00734	·00629	·00622	·00499	·00409	·00325	·00253	·00313	·00456	·00567	·00690	·00446
First part of 1843	·00301		·00505		·00278		·00000		·00052		·00103		·00261
Second part of 1843	·00372	·00913	·00343	·00600	·00443	·00344	·00178	·00134	·00156	·00265	·00179	·00513	·00303
First part of 1844	·00812	·00692	·00640	·00591	·00371	·00200	·00084	·00006	·00186	·00271	·00335	·00371	·00356
Second part of 1844	·00303	·00456	·00348	·00192	·00100	·00088	·00000	·00162	·00322	·00338	·00428	·00615	·00334
First part of 1845	·00553	·00411	·00282	·00286	·00269	·00110	·00086	·00158	·00116	·00283	·00409	·00530	·00267
Second part of 1845	·00641	·00553	·00333	·00200	·00111	·00014	·00000	·00051	·00043	·00259	·00437	·00646	·00335

TABLE II.

Numerical Values of the excess or defect of the Barometric Differences at the several Lunar Hours.

1st Part. From the Superior to the Inferior Passage.

	Lunar Hours.											
	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
First part of 1841	+·0031		+·0025		−·0020		−·0022		−·0012		+·0004	
Second part of 1841	+·0026		+·0008		−·0006		−·0017		+·0001		+·0010	
First part of 1842	+·0028		+·0015		−·0011		−·0005		−·0032		−·0006	
Second part of 1842	+·0033	+·0024	+·0012	+·0003	−·0013	−·0036	−·0038	−·0045	−·0034	−·0012	−·0009	+·0018
First part of 1843	+·0011		+·0015		−·0007		−·0006		+·0005		+·0011	
Second part of 1843	+·0040	+·0029	+·0018	+·0007	+·0004	−·0019	−·0032	−·0019	−·0018	−·0010	−·0012	−·0004
First part of 1844	+·0019	+·0018	+·0005	+·0002	−·0005	−·0031	−·0036	−·0033	−·0021	+·0001	+·0020	+·0038
Second part of 1844	+·0055	+·0049	+·0037	+·0031	+·0006	−·0016	−·0033	−·0027	−·0021	−·0012	−·0006	+·0002
First part of 1845	+·0041	+·0017	−·0002	−·0012	−·0015	−·0027	−·0011	−·0024	−·0015	+·0001	+·0004	+·0016
Second part of 1845	+·0044	+·0049	+·0028	+·0024	−·0006	−·0014	−·0031	−·0032	−·0017	+·0001	+·0008	+·0019

2nd Part. From the Inferior to the Superior Passage.

	Lunar Hours.											
	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
First part of 1841	+·0017	.....	+·0021	.....	+·0003	.....	−·0022	.....	−·0029	.....	+·0010	
Second part of 1841 ...	+·0036	.....	+·0024	.....	−·0024	.....	−·0036	.....	−·0026	.....	+·0005	
First part of 1842	+·0011	.....	+·0023	.....	−·0003	.....	−·0014	.....	−·0023	.....	+·0017	
Second part of 1842 ...	+·0036	+·0029	+·0018	+·0018	+·0005	−·0004	−·0012	−·0019	−·0013	+·0001	+·0012	+·0024
First part of 1843	+·0004	.....	+·0025	.....	−·0002	.....	−·0026	.....	−·0021	.....	−·0013	
Second part of 1843 ...	+·0005	+·0009	+·0002	+·0028	+·0012	+·0002	−·0014	−·0019	−·0017	−·0006	−·0014	+·0019
First part of 1844	+·0046	+·0034	+·0028	+·0023	+·0001	−·0016	−·0027	−·0035	−·0017	−·0008	−·0002	+·0002
Second part of 1844 ...	−·0003	+·0012	+·0001	−·0014	−·0023	−·0025	−·0033	−·0017	−·0001	·0000	+·0009	+·0028
First part of 1845	+·0029	+·0014	+·0002	+·0002	·0000	−·0016	−·0018	−·0011	−·0015	+·0002	+·0013	+·0026
Second part of 1845 ...	+·0031	+·0022	·0000	−·0013	−·0022	−·0032	−·0033	−·0028	−·0029	−·0008	+·0010	+·0031

Table III.

Excess or Defect of the Barometric Differences at the several Lunar Hours shown in Annual Means.

1st Part. From the Superior to the Inferior Passage.

	Lunar Hours.											
	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1841	+·0028	.....	+·0016	.....	−·0013	.....	−·0020	.....	−·0005	.....	+·0007	
First part of 1842, and first part of 1843 ...	+·0020	.....	+·0015	.....	−·0009	.....	−·0006	.....	−·0013	.....	+·0003	
Second part of 1842, and second part of 1843...	+·0036	+·0026	+·0015	+·0005	−·0008	−·0027	−·0035	−·0032	−·0026	−·0011	−·0010	+·0007
1844	+·0037	+·0032	+·0021	+·0016	·0000	−·0024	−·0034	−·0030	−·0021	−·0005	+·0007	+·0020
1845	+·0042	+·0033	+·0014	+·0006	−·0010	−·0020	−·0021	−·0028	−·0016	+·0001	+·0006	+·0018

2nd Part. From the Inferior to the Superior Passage.

	Lunar Hours.											
	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
1841	+·0026	.....	+·0022	.....	−·0010	.....	−·0029	.....	−·0027	.....	+·0007	
First part of 1842, and first part of 1843 ...	+·0008	.....	+·0024	.....	−·0003	.....	−·0024	.....	−·0022	.....	+·0002	
Second part of 1842, and second part of 1843...	+·0020	+·0019	+·0010	+·0023	+·0008	−·0001	−·0013	−·0019	−·0015	−·0003	−·0001	+·0002
1844	+·0021	+·0023	+·0013	+·0004	−·0011	−·0020	−·0030	−·0026	−·0009	−·0004	+·0004	+·0015
1845	+·0030	+·0018	+·0001	−·0005	−·0011	−·0024	−·0026	−·0020	−·0022	−·0003	+·0012	+·0029

Table IV.

Excess or Defect of the Barometric Differences at the several Lunar Hours as severally deduced from Hourly and 2-Hourly Observations.

1st Part. From the Superior to the Inferior Passage.

	Lunar Hours.											
	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Mean of two years.....	+·0024	.....	+·0015	.....	−·0011	.....	−·0013	.....	−·0009	.....	+·0005	.....
Mean of three years	+·0038	+·0030	+·0017	+·0009	−·0006	−·0024	−·0030	−·0030	−·0021	−·0005	+·0001	+·0015

2nd Part. From the Inferior to the Superior Passage.

	Lunar Hours.											
	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Mean of two years.....	+·0017	.....	+·0023	.....	−·0007	.....	−·0025	.....	−·0025	.....	+·0005	
Mean of three years	+·0024	+·0020	+·0008	+·0007	−·0005	−·0015	−·0023	−·0022	−·0015	−·0003	+·0004	+·0022

Table V.

Mean Variation of Barometric Pressure deduced from the Hourly Observations.

Moon's distance from the meridian.	Variations of barometric pressure.		Hourly variations.		Mean of three years at Singapore.	Mean of two years at St. Helena.	Moon's distance from the meridian.
	At the hours following the meridian passage.	At the hours preceding the meridian passage.	From the observations at the hours following the meridian passage.	From the observations at the hours preceding the meridian passage.			
h	h in. in.	h in. in.	in.	in.	in.	in.	h
0	0 +·0038 12 +·0024 +·0031	0 +·0038 12 +·0024 +·0031	+·0057	+·0057	+·00570	+·00365	0
1	1 +·0030 13 +·0020 +·0025	11 +·0015 23 +·0022 +·0018	+·0051	+·0044	+·00475	+·00336	1
2	2 +·0017 14 +·0008 +·0012	10 +·0001 22 +·0004 +·0002	+·0038	+·0028	+·00330	+·00275	2
3	3 +·0009 15 +·0007 +·0008	9 −·0005 21 −·0003 −·0004	+·0034	+·0022	+·00280	+·00158	3
4	4 −·0006 16 −·0005 −·0005	8 −·0021 20 −·0015 −·0018	+·0021	+·0008	+·00145	+·00110	4
5	5 −·0024 17 −·0015 −·0019	7 −·0030 19 −·0022 −·0026	+·0007	·0000	+·00035	+·00046	5
6	6 −·0030 18 −·0023 −·0026	6 −·0030 18 −·0023 −·0026	·0000	·0000	·00000	·00000	6

CURVES OF THE LUNAR ATMOSPHERIC TIDE.

Phil. Trans. MDCCCLII. Plate X. p. 126.

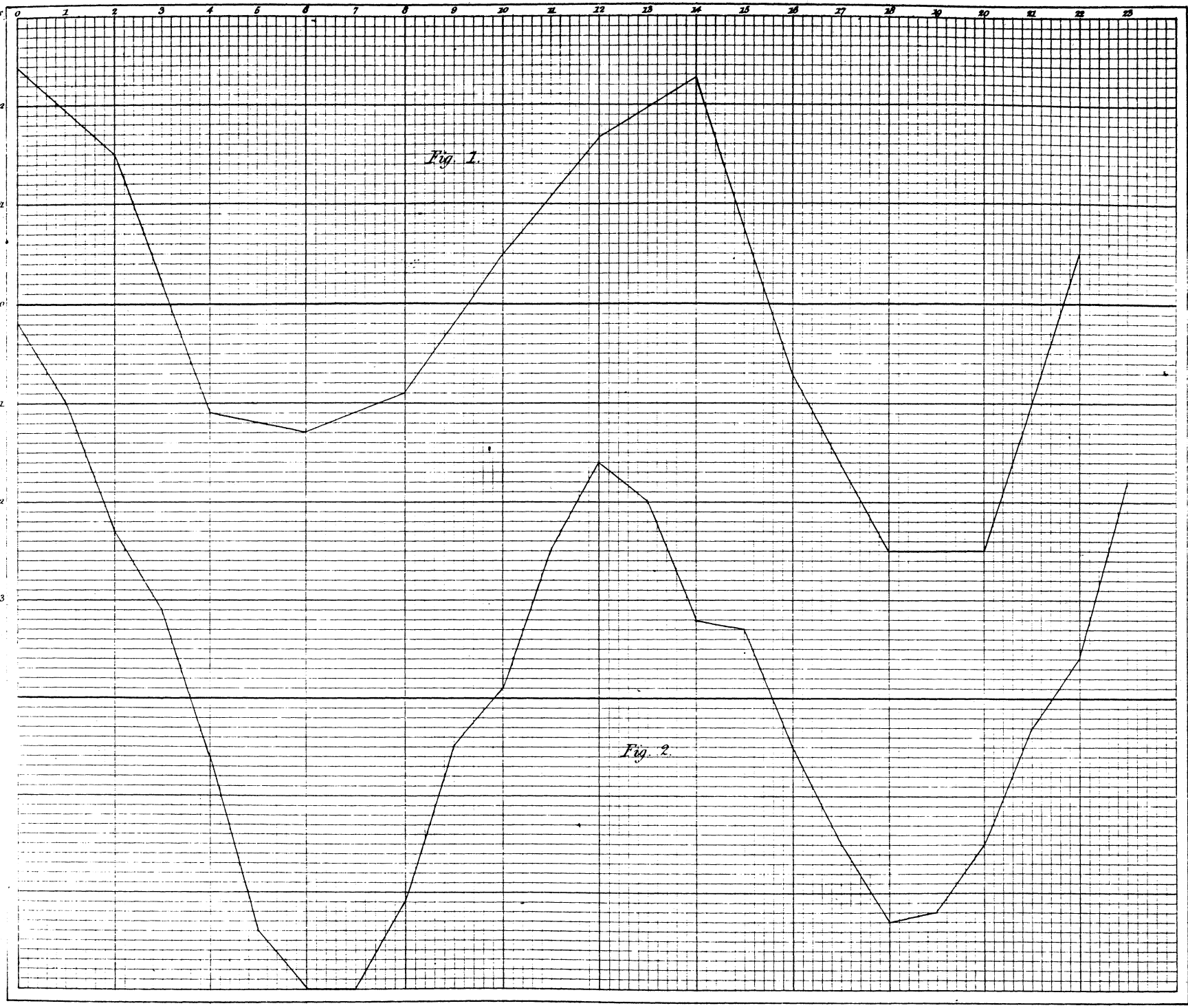

Fig. 1. From 24 months of 2 hourly observations.

Fig. 2. From 36 months of hourly observations.

J. Basire sc.

Scale .001 of an Inch of Barometric Pressure to 0.74 of an Inch.

The Curve rising denotes an increase of Barometric Pressure.