XII. *Researches on the Tides.—Eleventh Series. On certain Tide Observations made in the Indian Seas.* *By the Rev.* W. WHEWELL, *B.D. F.R.S., Fellow of Trinity College, Cambridge.*

Received April 11,—Read June 6, 1839.

CERTAIN series of tide observations, made at several places in the Indian Seas, having been forwarded to the Admiralty by the Honourable East India Company, I examined these by the assistance of Mr. D. Ross of the Hydrographer's Office. The observations were very incomplete, as the following account of them will show. But as the tides of those seas offer some very curious phenomena, I endeavoured to discover how far these phenomena were illustrated by the observations thus sent; and I now lay the results of this examination before the Society, in order that they may be preserved, and combined with any information obtained hereafter from these seas. The places of observation were

Coringa Bay, on the coast of Golconda . .	Lat. N.	16°	49′	Long. E.	82°	6′
Cochin, on the Malabar coast		9	57½		76	29
Surat Roads, in the Gulf of Cambay . . .		21	11		73	5½
Gogah, on the opposite side of the Gulf of Cambay		21	41		72	23
Bassadore, at the western extremity of the Island of Kismis, at the entrance of the Persian Gulf		26	39		55	32

1. *At Cochin.*—Although there are two years' tides (1836, 1837) for this place, still they are only taken once in twenty-four hours; and on examination of the heights they seldom vary more than one foot from spring to neap, but the range is only three feet.

2. *Coringa River.*—The observations are also for two years, 1836 and 1837, at this place, but only once in twenty-four hours. These tides appear to be more carefully taken both in times and heights than at Cochin.

3. *In Surat Roads.*—The tides were taken on board an Indian brig, and then only when in harbour, commencing October 18, 1834, and continued to the 23rd. A gap takes place as the brig goes on a cruize till the 31st. Tides continued to Nov. 18; gap to 21st. Tides to December 20; gap to January 7, 1835. Tides to March 29; gap to April 5. Observations end 25th. These tides are for A.M. and P.M.

4. *At Gogah.*—These observations seem to be the most regular; they are taken

at A.M. and P.M.; but there are not four months of them, as they commence on the 10th of June, and end September 30, 1835.

5. *At Bassadore.*—The tides at this place are taken for a few days in September; a few days in October, and the whole of November for 1834.

In the first place, I proceeded to find the establishment of each place, and the semi-menstrual inequality so far as the observations allowed. The following are the results.

	Lunitidal Interval.		Mean, or correct establishment.	Difference.
	Least.	Greatest.		
	h m	h m	h m	m
Coringa Bay ..	9 25	10 39 =	10 2	74
Cochin	0 32	2 21 =	1 $26\frac{1}{2}$	109
Surat	3 49	4 59 =	4 24	70
Gogah	4 6	5 27 =	4 $46\frac{1}{2}$	81

In the second place, it appeared that at the two places in the Gulf of Cambay, there is an enormous diurnal inequality of the heights, amounting at both Surat and Gogah to not less than seven or eight feet. The observations being laid down in curves, this feature was more marked than in any case which I have yet examined, even than Singapore, of which the curve was given in the Philosophical Transactions for 1837.

The observations give this inequality at Surat and Gogah somewhat irregularly, but not so much so as to prevent my obtaining its epoch in an approximate manner. It appears that the diurnal inequality disappears, and changes its sign, about two days after the moon's declination vanishes.

In the third place, it appeared that at Bassadore there is a very large diurnal inequality of the *times*, amounting to above two hours in some instances. This is a new case: for though I had already ascertained that in some places there is a diurnal inequality of the lunitidal intervals, I had never supposed that it could amount to a quantity so large as this, which indeed utterly displaces the tides. For instance, about the 23rd of November 1834, the tides on the afternoon of each day were earlier by about two hours than the hour of the tides in the forenoon. What makes this anomaly still more remarkable is, that at this place there is little or no diurnal inequality of the heights. As this result is a very novel one, I shall here give a copy of the original observations.

Bassadore Original Tide Register for the Month of November 1834.

	Low Water.		High Water.		Range.		Low Water.		High Water.		Range.
	Time.	Height.	Time.	Height.			Time.	Height.	Time.	Height.	
	h m	ft. in.	h m	ft. in.	ft. in.		h m	ft. in.	h m	ft. in.	ft. in.
Nov. 1 A.M.	5 35	1 6	11 58	9 0	7 6	Nov. 16 A.M.	5 55	3 0	11 55	9 0	6 0
P.M.	6 32	0 0	....	....	....	P.M.	6 43	0 6	13 12	8 6	8 0
2 A.M.	6 15	1 0	0 26	9 6	8 6	17 A.M.	6 17	2 0	11 34	8 6	6 6
P.M.	7 4	0 0	0 30	9 6	9 6	P.M.	6 35	1 6	13 22	9 0	7 6
3 A.M.	7 1	1 0	1 23	9 6	8 6	18 A.M.	4 46	2 0	....	....	....
P.M.	8 3	1 0	1 2	9 0	8 0	P.M.	7 44	3 0	37	9 0	6 0
4 A.M.	7 39	1 0	2 14	9 0	8 0	19 A.M.	7 24	3 0	2 12	8 6	5 6
P.M.	8 53	2 0	1 32	9 6	7 6	P.M.	8 20	1 6	1 6	8 6	7 0
5 A.M.	8 28	2 0	3 26	9 0	7 0	20 A.M.	7 57	2 0	2 55	9 0	7 0
P.M.	8 33	2 0	2 17	9 0	7 0	P.M.	9 7	2 0	1 35	9 0	7 0
6 A.M.	9 13	2 6	4 4	9 0	6 6	21 A.M.	8 48	3 0	3 57	8 6	5 6
P.M.	10 16	2 6	2 58	9 0	6 6	P.M.	9 44	2 6	2 8	9 0	6 6
7 A.M.	10 10	2 6	5 0	8 6	6 0	22 A.M.	9 16	2 0	4 34	8 6	6 6
P.M.	11 14	4 0	3 38	8 0	4 0	P.M.	10 30	3 0	2 38	8 6	5 6
8 A.M.	11 35	4 0	6 15	7 6	3 6	23 A.M.	13 13	4 0	5 33	8 6	4 6
P.M.	....	....	5 3	7 6		P.M.	11 39	4 0	3 41	8 0	4 0
9 A.M.	26	2 6	7 35	7 0	4 6	24 A.M.	11 27	4 0	6 43	8 0	4 0
P.M.	1 18	4 0	7 7	7 6	3 6	P.M.	....	....	5 7	8 6	
10 A.M.	2 48	3 0	8 41	7 0	4 0	25 A.M.	0 52	4 0	7 50	8 0	4 0
P.M.	2 9	3 0	7 27	7 0	4 0	P.M.	1 4	4 0	6 29	9 0	5 0
11 A.M.	2 23	3 0	9 40	8 0	5 0	26 A.M.	1 52	4 0	8 48	8 6	4 6
P.M.	4 3	3 0	9 41	8 0	5 0	P.M.	2 32	3 0	8 8	9 6	6 6
12 A.M.	3 50	3 0	10 30	8 0	5 0	27 A.M.	2 30	3 0	9 12	9 0	6 0
P.M.	4 58	3 0	10 25	8 0	5 0	P.M.	2 31	2 0	9 38	9 0	7 0
13 A.M.	5 4	3 0	10 42	9 0	6 0	28 A.M.	3 39	2 0	9 37	9 0	7 0
P.M.	6 25	3 0	11 7	9 0	6 0	P.M.	4 20	1 0	10 42	9 0	7 0
14 A.M.	4 23	4 0	10 44	9 0	5 0	29 A.M.	4 12	1 0	10 21	9 6	8 6
P.M.	5 43	3 0	11 54	9 0	6 0	P.M.	5 18	1 0	11 49	10 0	9 0
15 A.M.	5 15	3 0	11 26	9 0	6 0	30 A.M.	5 20	2 0	11 15	9 9	7 9
P.M.	6 8	3 0	12 29	9 0	6 0	P.M.	6 9	0 0	12 22	9 9	9 9

To this table there is no signature, but all the others for Bassadore are signed Thomas Elroon, Commodore.

In order to bring into view the diurnal inequality of the times in these observations, we take out the times of moon's transit, corrected for the longitude of Bassadore. We hence find the interval between each transit and the succeeding time of high water, as will be seen below; and it appears that the *lunitidal intervals* vary from $9^h\ 48^m$ to $13^h\ 33^m$. At the beginning of the month the successive lunitidal intervals are equal. About the 7th they become alternately about 12^h and 10^h, or 13^h and 11^h; on the 12th they are again equal; about the 19th they again become alternately about 12^h and 10^h. The difference gradually diminishes to the 20th, when they are again equal; after which the inequality reappears, and continues to the end of the month.

This diurnal inequality of above two hours in the time of high water, in a situation in which the diurnal inequality of height is insensible, I cannot but consider as a most curious tidal feature in addition to those already remarked in the Indian Seas.

	Moon's Transit.	Succeeding Tide.	Lunitidal Interval.		Moon's Transit.	Succeeding Tide.	Lunitidal Interval.
	h m	h m	h m		h m	h m	h m
1834. 31	23 48	11 58	12 10	Nov. 16	12 5	13 12	13 7
Nov. 1					12 28	11 34	11 6
	16	26	12 10	17	12 52	13 22	12 30
2	45	30	11 45		13 17	37	11 20
	1 14	1 23	12 9	18	13 42	2 12	12 30
3	1 44	1 2	11 18		14 8	1 6	10 58
	2 14	2 14	12 0	19	14 35	2 55	12 20
4	2 44	1 32	10 48		15 2	1 35	10 33
	3 14	3 26	12 12	20	15 29	3 57	12 28
5	3 43	2 17	10 34		15 56	2 8	10 12
	4 12	4 4	11 52	21	16 23	4 34	12 11
6	4 41	2 58	10 17		16 50	2 38	9 48
	5 8	5 0	11 52	22	17 17	5 33	12 16
7	5 35	3 38	10 3		17 43	3 41	9 58
	6 1	6 15	12 14	23	18 8	6 43	12 35
8	6 26	5 3	10 37		18 34	5 7	10 33
	6 49	7 35	12 46	24	18 59	7 50	12 51
9	7 12	7 7	11 55		19 24	6 29	11 5
	7 34	8 41	13 7	25	19 49	8 48	12 59
10	7 56	7 27	11 31		20 14	8 8	11 54
	8 17	9 40	13 23	26	20 40	9 12	12 32
11	8 37	9 41	13 4		21 6	9 38	12 32
	8 57	10 30	13 33	27	21 32	9 37	12 5
12	9 17	10 25	13 8		21 59	10 42	12 43
	9 37	10 42	13 5	28	22 26	10 21	11 55
13	9 57	11 7	13 10		22 54	11 49	12 55
	10 17	10 44	12 27	29	23 23	11 15	11 52
14	10 38	11 54	13 16		23 53	12 22	12 29
	10 59	11 26	12 27	30			
15	11 20	12 29	13 9				
	11 42	11 55	12 13				