XIII. *On the Tides of the Arctic Seas.*

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Part VI. *Tides of Port Kennedy, in Bellot Strait.*

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The following observations were made by Admiral Sir Leopold M'Clintock (then Captain) in the month of July 1859, at Port Kennedy, in Bellot Strait, on board the yacht 'Fox,' in eleven fathoms depth, lat. 72° 01′ N., long. 94° 15′ W. The observations were made hourly, and, judging from the consistent and highly interesting results obtained from them, they must have been made and recorded with unusual care.

In Table I. the first column contains the Solar Hour, the second contains the Height of Tide, the third contains the Diurnal Tide, and the fourth the Semidiurnal Tide.

The Diurnal Tide was calculated as follows:—Let h_1, h_2, h_3 be the heights of the water at three periods, separated by intervals of twelve hours each, then the Diurnal Tide corresponding to the height h_2 is

$$D=\frac{h_1-2h_2+h_3}{4}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The third column was calculated from the second by this formula, and the fourth column, containing the Semidiurnal Tide only, is the algebraical sum of the second and third columns.

TABLE I.—Hourly Values of the Diurnal and Semidiurnal Tide at Port Kennedy in July 1859.

5th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.			
1.	5 2		
2.	5 11		
3.	6 2½		
4.	6 3		
5.	6 0½		
6.	5 7		
7.	4 9½		
8.	4 2½		
9.	3 9½		
10.	3 7		
11.	4 0½		
Midnight.	5 2		
13.	6 10	−0 8	6 2
14.	8 1	−1 2	6 11
15.	9 3	−1 5¾	7 9¼
16.	10 0	−1 8¾	8 3¼
17.	10 0½	−1 9½	8 3
18.	9 3½	−1 6¾	7 8¾
19.	7 11½	−1 3	6 8
20.	6 8	−0 10¾	5 9¼
21.	5 5	−0 6½	4 10½
22.	4 8	−0 3¼	4 4¾
23.	4 1	+0 1	4 2
		Mean ...	6 8¾

6th July.			
Noon.	4 2	+0 5	4 7
1.	4 9½	+0 6	5 3½
2.	5 8½	+0 11	6 7½
3.	6 4½	+1 2	7 6½
4.	6 10	+1 3½	8 1½
5.	6 11	+1 5½	8 4½
6.	6 9	+1 2½	7 11½
7.	6 2	+0 11¼	7 1¼
8.	5 6½	+0 7¾	6 2¼
9.	4 11	+0 4	5 3
10.	4 8	+0 1	4 9
11.	4 5½	−0 2	4 3½
Midnight.	4 10½	−0 5¼	4 5¼
13.	5 9	−0 7½	5 1½
14.	7 0	−0 10½	6 1½
15.	8 1½	−1 0¾	7 0¾
16.	8 10	−1 1	7 9
17.	9 8	−1 4½	8 3½
18.	9 1	−1 4	7 9
19.	8 1½	−0 9	7 4½
20.	7 0	−0 5	6 7
21.	5 9½	−0 1½	5 8
22.	5 0	+0 1½	5 1½
23.	4 2	+0 5¼	4 7¼
		Mean ...	6 4

7th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	3 10	+0 9¼	4 7¼
1.	4 0	+0 11¼	4 11¼
2.	4 9½	+1 0¾	5 10¼
3.	5 8	+1 1¾	6 9¾
4.	6 5½	+1 1	7 6½
5.	6 11	+1 2¼	8 1¼
6.	7 1	+1 0½	8 1½
7.	7 0½	+0 8¾	7 9½
8.	6 9	+0 5	7 2
9.	6 2	+0 2	6 4
10.	5 10	−0 1½	5 8½
11.	5 8	−0 5	5 3
Midnight.	5 10½	−0 9½	5 1
13.	6 0	−0 10¼	5 1¾
14.	6 10	−1 0	5 10
15.	7 9	−1 0¾	6 8¼
16.	8 5	−0 11½	7 5½
17.	8 11	−0 11	8 0
18.	9 2½	−0 10¼	8 4¼
19.	8 10½	−0 7½	8 3
20.	8 2½	−0 4¼	7 10¼
21.	7 2½	+0 1	7 3½
22.	6 2	+0 3¼	6 5¼
23.	5 6	+0 6½	6 0½
		Mean ...	6 7¾

8th July.			
Noon.	4 9½	+0 9½	5 7
1.	4 7	+0 10½	5 5½
2.	4 11	+1 0¼	5 11¼
3.	5 7	+1 0¼	6 7¼
4.	6 6	+0 10	7 4
5.	7 2½	+0 9	7 11½
6.	7 10½	+0 6¾	8 5¼
7.	8 2½	+0 3¾	8 6¼
8.	8 3	+0 1	8 4
9.	7 11	−0 2¼	7 8¾
10.	7 7	−0 5¾	7 1¼
11.	7 2	−0 8	6 6
Midnight.	6 11	−0 10½	6 0½
13.	6 8	−0 11¼	5 8¾
14.	7 1½	−1 1	6 0½
15.	7 6	−1 0	6 6
16.	7 11½	−0 9½	7 2
17.	8 6	−0 8	7 10
18.	8 9½	−0 4½	8 5
19.	8 9½	−0 1¾	8 7¾
20.	8 7	+0 1	8 8
21.	7 10½	+0 5	8 3½
22.	7 1	+0 8¼	7 9¼
23.	6 2½	+0 11	7 1½
		Mean ...	7 2¾

TABLE I. (continued).

9th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
N n.	5 7	+1 1	6 8
1.	5 0	+0 11	5 11
2.	5 0½	+0 10¾	5 11¼
3.	5 5	+1 0	6 5
4.	6 2½	+0 11½	7 2
5.	7 1	+0 8½	7 9½
6.	8 2	+0 3¼	8 5¼
7.	8 9½	±0 0	8 9½
8.	9 2½	−0 3	8 11½
9.	9 5½	−0 11	8 6½
10.	9 4	−0 10¾	8 5¼
11.	8 11	−1 1	7 10
Midnight.	8 7	−1 2¼	7 4¾
13.	7 0	−0 9	6 3
14.	6 7	−0 7½	5 11½
15.	7 3½	−0 10¼	6 5¼
16.	8 4	−1 1	7 3
17.	8 6	−0 9½	7 8½
18.	8 7½	−0 1	8 6½
19.	8 10	+0 1	8 11
20.	8 9½	+0 3½	9 1
21.	8 4	+0 6	8 10
22.	8 0	+0 8¼	8 8¼
23.	7 3	+0 11¾	8 2¾
		Mean ...	7 8

10th July.			
Noon.	6 10	+1 0¾	7 10¾
1.	6 0	+0 11	6 11
2.	5 7½	+0 10¼	6 5¾
3.	5 9	+1 1	6 10
4.	6 1	+1 2	7 3
5.	6 9	+0 10	7 7
6.	7 8½	+0 4¼	8 0¾
7.	8 9½	−0 0¾	8 8¾
8.	9 6½	−0 6	9 0½
9.	9 2	−0 5	8 9
10.	9 5	−0 8¼	8 8¾
11.	9 6	−1 0¾	8 5¼
Midnight.	9 4	−1 2	8 2
13.	8 9½	−1 1½	7 8
14.	8 1⅓	−0 10¾	7 2¾
15.	8 7	−1 1¼	7 5¾
16.	8 6	−1 0	7 6
17.	8 4	−0 9	7 7
18.	8 4	−0 6	7 10
19.	8 4	−0 2½	8 1½
20.	8 4	+0 3	8 7
21.	8 4	+0 3¾	8 7¾
22.	8 1	+0 9½	8 10½
23.	7 6	+1 1¾	8 7¾
		Mean ...	7 11½

11th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	7 2	+1 3½	8 5½
1.	7 1	+1 1	8 2
2.	7 0½	+0 9	7 9½
3.	7 0	+0 10	7 10
4.	6 11½	+0 9¼	7 8¾
5.	6 11½	+0 8¾	7 8¼
6.	7 0	+0 8½	7 8½
7.	7 1	+0 8	7 9
8.	8 1	+0 2	8 3
9.	8 9	−0 4	8 5
10.	9 11	−0 11¾	8 11¼
11.	10 1	−1 4	8 9
Midnight.	10 1½	−1 6½	8 7
13.	9 8	−1 6	8 2
14.	9 0	−1 1½	7 10½
15.	8 9	−1 5	7 4
16.	8 6	−1 4¾	7 1¼
17.	8 6	−1 4½	7 1½
18.	8 6	−0 11¼	7 6¾
19.	8 6	−0 11	7 7
20.	8 6	−0 4½	8 1½
21.	7 9½	+0 2	7 11½
22.	7 10	+0 8½	8 6½
23.	7 4½	+1 6¼	8 10¾
		Mean ...	7 11¾

12th July.			
Noon.	6 10½	+1 8¼	8 6¾
1.	6 2½	+1 8¾	7 11¼
2.	6 5½	+1 3¼	7 8¾
3.	4 9½	+1 11	6 8½
4.	4 5	+1 8¼	6 1¼
5.	4 6	+1 9¼	6 3¼
6.	5 0½	+1 5	6 5½
7.	6 3	+0 9½	7 0½
8.	7 5	+0 2½	7 7½
9.	7 6½	+0 0½	7 7
10.	8 7½	−0 5¼	8 2¼
11.	10 9	−1 7½	9 1½
Midnight.	10 5	−1 7½	8 9½
13.	9 8	−1 7½	8 0½
14.	9 0½	−1 4½	7 8
15.	8 5½	−1 8	6 9½
16.	8 1	−1 10¾	6 2¼
17.	7 7	−1 6¼	6 0¾
18.	7 3	−1 1½	6 1½
19.	7 1½	−0 6½	6 7
20.	7 2	+0 0½	7 2½
21.	7 6	+0 9¼	8 3¼
22.	7 8	+0 9	8 5
23.	7 8	+1 5¼	9 1¼
		Mean ...	7 1¼

TABLE I. (continued).

13th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	7 5	+1 7¾	9 0¾
1.	6 7	+2 0	8 7
2.	6 2	+1 11¼	8 1¼
3.	5 6	+1 7	7 1
4.	4 2	+2 2¼	6 4¼
5.	4 7	+1 7	6 2
6.	4 11	+1 2¾	6 1¾
7.	5 10	+0 8	6 6
8.	7 1	+0 0¼	7 1¼
9.	8 7	−0 7¼	7 11¾
10.	9 6	−0 11¼	8 6¼
11.	10 4	−1 4	9 0
Midnight.	11 0	−1 9	9 3
13.	11 6½	−2 3½	9 3
14.	11 1	−2 4¾	8 8¼
15.	10 2	−2 2¾	7 10¼
16.	9 0	−2 2½	6 9½
17.	7 11	−1 8¼	6 2¾
18.	7 6	−1 4¾	6 1¼
19.	7 2½	−0 11½	6 3
20.	7 1	−0 3¼	6 9¾
21.	7 3½	+0 4¾	7 8¼
22.	7 7	+0 10¼	8 5¼
23.	7 8½	+1 2½	8 11
		Mean ...	7 7½

14th July.			
Noon.	7 7½	+1 8¾	9 4¼
1.	7 3½	+2 2	9 5½
2.	6 5	+2 5½	8 10½
3.	5 7	+2 4¾	7 11¾
4.	5 0	+2 2¼	7 2¼
5.	4 6	+1 10½	6 4½
6.	4 5	+1 6¾	5 11¾
7.	4 9	+1 2½	5 11½
8.	6 1	+0 5½	6 6½
9.	7 7	−0 2½	7 4½
10.	9 1	−0 9	8 4
11.	9 11	−1 5½	8 5½
Midnight.	11 2	−1 5	9 9
13.	11 8	−1 9½	9 10½
14.	11 6½	−2 4¼	9 2¼
15.	10 7	−2 3¾	8 3¼
16.	9 9	−2 2½	7 6½
17.	8 7	−2 0¼	6 6¾
18.	7 7	−1 7½	5 11½
19.	7 2	−1 3	5 11
20.	7 0	−0 7	6 5
21.	7 1	+0 0¾	7 1¾
22.	7 6½	+0 6¾	8 1¼
23.	7 11½	+0 10¾	8 10¼
		Mean ...	8 1¾

15th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	8 1	+1 3½	9 4½
1.	7 10	+1 5½	9 3½
2.	7 3	+1 9	9 0
3.	6 4	+1 11½	8 3½
4.	5 8	+1 10½	7 6½
5.	4 7	+1 10¾	6 5¾
6.	4 2½	+1 7¾	5 10¼
7.	4 6½	+1 3½	5 10
8.	5 5	+0 9½	6 2½
9.	6 10	+0 2	7 0
10.	8 3	−0 4	7 11
11.	9 7	−0 9¾	8 9¼
Midnight.	9 10	−0 11	8 11
13.	9 10	−0 11½	8 10½
14.	9 11	−1 3	8 8
15.	9 11	−1 7½	8 3½
16.	9 1	−1 7¼	7 5¾
17.	8 2	−1 7½	6 6½
18.	7 5	−1 6	5 11
19.	7 0½	−1 3½	5 9
20.	7 0½	−0 11½	6 1
21.	7 2½	−0 3¼	6 11¼
22.	7 7½	+0 2¾	7 10¼
23.	7 11½	+0 6¼	8 5¾
		Mean ...	7 6¾

16th July.			
Noon.	7 11½	+0 10½	8 10
1.	8 0½	+1 1¾	9 2¼
2.	7 7	+1 7	9 2
3.	7 0½	+1 10½	8 11
4.	6 1	+1 10	7 11
5.	5 3	+1 9¾	7 0¾
6.	4 7	+1 7¾	6 2¾
7.	4 5	+1 5½	5 10½
8.	4 10	+1 1½	5 11½
9.	6 6	+0 3¾	6 9¾
10.	7 11	−0 0½	7 10½
11.	8 5	−0 4	8 1
Midnight.	9 7	−0 9½	8 9½
13.	10 10	−1 1	9 9
14.	11 7	−1 10½	9 8½
15.	11 8	−2 2½	9 5½
16.	10 5	−1 11¾	8 5¼
17.	9 7	−1 11½	7 7½
18.	8 4	−1 8¼	6 7¾
19.	7 8	−1 3½	6 4½
20.	7 2	−1 2½	5 11½
21.	7 0½	−0 6¼	6 6¼
22.	7 0	+0 2¼	7 2¼
23.	7 6	+0 4¼	7 10¼
		Mean ...	7 9

TABLE I. (continued).

17th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	8 0	+0 $8\frac{1}{2}$	8 $8\frac{1}{2}$
1.	8 3	+1 1	9 4
2.	8 1	+1 $7\frac{3}{4}$	9 $8\frac{3}{4}$
3.	7 6	+2 $0\frac{1}{4}$	9 $6\frac{1}{4}$
4.	6 10	+1 $11\frac{1}{2}$	8 $9\frac{1}{2}$
5.	6 $0\frac{1}{2}$	+1 $10\frac{3}{4}$	7 $11\frac{1}{4}$
6.	5 4	+1 $7\frac{1}{4}$	6 $11\frac{1}{4}$
7.	4 9	+1 $5\frac{3}{4}$	6 $2\frac{3}{4}$
8.	4 $8\frac{1}{2}$	+1 $2\frac{1}{2}$	5 11
9.	5 6	+0 $11\frac{1}{2}$	6 $5\frac{1}{2}$
10.	6 10	−0 $0\frac{1}{2}$	6 $9\frac{1}{2}$
11.	8 0	−0 $4\frac{1}{2}$	7 $7\frac{1}{2}$
Midnight.	9 3	−0 $8\frac{1}{2}$	8 $6\frac{1}{2}$
13.	10 0	−0 11	9 1
14.	11 2	−1 5	9 9
15.	11 5	−1 10	9 7
16.	11 1	−1 $11\frac{1}{2}$	9 $1\frac{1}{2}$
17.	10 1	−1 $10\frac{1}{4}$	8 $2\frac{3}{4}$
18.	8 9	−1 $7\frac{1}{4}$	7 $1\frac{3}{4}$
19.	7 9	−1 $4\frac{1}{2}$	6 $4\frac{1}{2}$
20.	7 1	−1 $1\frac{1}{2}$	5 $11\frac{1}{2}$
21.	6 $9\frac{1}{2}$	−0 $8\frac{3}{4}$	6 $0\frac{3}{4}$
22.	6 6	±0 0	6 6
23.	7 0	+0 $4\frac{3}{4}$	7 $11\frac{1}{4}$
		Mean ...	7 10

19th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	7 $0\frac{1}{2}$	+0 $6\frac{1}{4}$	7 $6\frac{3}{4}$
1.	7 6	+0 $10\frac{3}{4}$	8 $4\frac{3}{4}$
2.	8 0	+0 $11\frac{3}{4}$	8 $11\frac{3}{4}$
3.	8 1	+1 0	9 1
4.	7 8	+1 $2\frac{1}{4}$	8 $10\frac{1}{4}$
5.	7 2	+1 4	8 6
6.	6 2	+1 $6\frac{3}{4}$	7 $8\frac{3}{4}$
7.	5 6	+1 3	6 9
8.	5 3	+0 10	6 1
9.	5 1	+0 $7\frac{1}{4}$	5 $8\frac{1}{4}$
10.	5 5	+0 $5\frac{1}{2}$	5 $10\frac{1}{2}$
11.	6 5	+0 $0\frac{1}{2}$	6 $5\frac{1}{2}$
Midnight.	7 9	−0 6	7 3
13.	8 11	−0 $9\frac{3}{4}$	8 $1\frac{1}{4}$
14.	9 10	−0 $11\frac{3}{4}$	8 $10\frac{1}{4}$
15.	10 0	−0 $11\frac{3}{4}$	9 $0\frac{1}{4}$
16.	10 1	−1 $1\frac{3}{4}$	8 $11\frac{3}{4}$
17.	10 0	−1 4	8 8
18.	9 $3\frac{1}{2}$	−1 $4\frac{1}{2}$	7 11
19.	8 1	−1 $1\frac{1}{2}$	6 $11\frac{1}{2}$
20.	7 2	−0 10	6 4
21.	6 5	−0 7	5 10
22.	6 2	−0 4	5 10
23.	6 0	+0 2	6 2
		Mean ...	7 $5\frac{1}{2}$

18th July.			
Noon.	7 8	+0 $10\frac{3}{4}$	8 $6\frac{3}{4}$
1.	8 $1\frac{1}{2}$	+0 $10\frac{1}{4}$	8 $11\frac{3}{4}$
2.	8 $2\frac{1}{2}$	+1 $2\frac{1}{2}$	9 5
3.	8 $0\frac{1}{2}$	+1 $3\frac{1}{2}$	9 4
4.	7 6	+1 $6\frac{1}{4}$	9 $0\frac{1}{4}$
5.	6 8	+1 $7\frac{1}{4}$	8 $3\frac{1}{4}$
6.	5 9	+1 $7\frac{1}{4}$	7 $4\frac{1}{4}$
7.	5 3	+1 $3\frac{1}{2}$	6 $6\frac{1}{2}$
8.	5 0	+0 $11\frac{1}{4}$	5 $11\frac{1}{4}$
9.	5 2	+0 8	5 10
10.	6 2	+0 2	6 4
11.	7 5	−0 $2\frac{1}{2}$	7 $2\frac{1}{2}$
Midnight.	8 $5\frac{1}{2}$	−0 $6\frac{1}{2}$	7 11
13.	9 8	−0 11	8 9
14.	10 1	−1 0	9 1
15.	10 2	−1 $0\frac{1}{2}$	9 $1\frac{1}{2}$
16.	10 0	−1 $2\frac{1}{2}$	8 $9\frac{1}{2}$
17.	9 8	−1 $4\frac{1}{2}$	8 $3\frac{1}{2}$
18.	9 $1\frac{1}{2}$	−1 7	7 $6\frac{1}{2}$
19.	7 11	−1 $3\frac{1}{4}$	6 $7\frac{3}{4}$
20.	6 8	−0 $9\frac{1}{4}$	5 $10\frac{3}{4}$
21.	6 3	−0 $6\frac{3}{4}$	5 $8\frac{1}{4}$
22.	6 6	−0 $4\frac{1}{4}$	6 $1\frac{3}{4}$
23.	7 $0\frac{1}{2}$	−0 2	6 $10\frac{1}{2}$
		Mean ...	7 $7\frac{3}{4}$

20th July.			
Noon.	6 6	+0 $5\frac{3}{4}$	6 $11\frac{3}{4}$
1.	7 1	+0 $9\frac{1}{2}$	7 $10\frac{1}{2}$
2.	7 9	+0 $11\frac{1}{2}$	8 $8\frac{1}{2}$
3.	8 0	+0 $11\frac{3}{4}$	8 $11\frac{3}{4}$
4.	7 11	+1 1	9 0
5.	7 6	+1 $3\frac{1}{2}$	8 $9\frac{1}{2}$
6.	6 11	+1 $3\frac{1}{4}$	8 $2\frac{1}{4}$
7.	6 2	+1 $0\frac{3}{4}$	7 $2\frac{3}{4}$
8.	5 9	+0 9	6 6
9.	5 5	+0 $6\frac{1}{2}$	5 $11\frac{1}{2}$
10.	5 $6\frac{1}{2}$	+0 3	5 $9\frac{1}{2}$
11.	6 3	−0 $2\frac{1}{2}$	6 $0\frac{1}{2}$
Midnight.	7 2	−0 $5\frac{3}{4}$	6 $8\frac{1}{4}$
13.	8 5	−0 $9\frac{3}{4}$	7 $7\frac{1}{4}$
14.	9 6	−1 0	8 6
15.	9 11	−1 1	8 10
16.	10 1	−1 2	8 11
17.	10 2	−1 $3\frac{3}{4}$	8 $10\frac{1}{4}$
18.	9 8	−1 $3\frac{1}{4}$	8 $4\frac{3}{4}$
19.	8 6	−1 $0\frac{1}{4}$	7 $5\frac{3}{4}$
20.	7 4	−0 8	6 8
21.	6 5	−0 $4\frac{1}{4}$	6 $0\frac{3}{4}$
22.	5 11	−0 1	5 10
23.	5 8	+0 $2\frac{3}{4}$	5 $10\frac{3}{4}$
		Mean ...	7 6

TABLE I. (continued).

21st July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	5 11	+0 5	6 4
1.	6 6	+0 8½	7 2½
2.	7 2½	+0 9½	8 0
3.	7 6	+0 10¾	8 4¾
4.	7 7	+1 0½	8 7½
5.	7 7	+1 1½	8 8½
6.	7 4	+1 0	8 4
7.	6 9	+0 9¼	7 6¼
8.	6 2½	+0 6¼	6 8¾
9.	6 0	+0 2¼	6 2¼
10.	5 11	−0 1	5 10
11.	6 0	−0 3½	5 8½
Midnight.	6 4½	−0 5¼	5 11¼
13.	7 4½	−0 6¾	6 9¾
14.	8 1	−0 7	7 6
15.	8 8	−0 8	8 0
16.	9 3	−0 10½	8 4½
17.	9 6	−1 0	8 6
18.	9 0	−0 10½	8 1½
19.	8 1	−0 8	7 5
20.	7 2	−0 5¼	6 8¾
21.	6 4	−0 1½	6 2½
22.	5 7	+0 2¾	5 9¾
23.	5 2	+0 6	5 7
		Mean...	7 2¼

22nd July.			
Noon.	5 1	+0 9	5 10
1.	6 0	+0 7¾	6 7¾
2.	6 8	+0 6¾	7 2¾
3.	7 2	+1 1½	8 3½
4.	7 4½	+0 9	8 1½
5.	7 4½	+0 10½	8 3
6.	7 1½	+0 10	7 11½
7.	6 9	+0 8	7 5
8.	6 4	+0 5¾	6 9¾
9.	6 2	+0 1¼	6 3¼
10.	6 2	−0 2¾	5 11¼
11.	6 4	−0 7	5 9
Midnight.	6 9	−0 10½	5 10½
13.	7 2	−0 9¾	6 4¼
14.	7 6	−0 8¼	6 9¾
15.	8 2	−0 10½	7 3½
16.	8 6	−1 0	7 6
17.	8 9	−0 7½	8 1½
18.	8 7½	−0 7½	8 0
19.	8 1	−0 5	7 8
20.	7 5	−0 2¾	7 2¼
21.	6 5	+0 3	6 8
22.	5 10	+0 4½	6 2½
23.	5 2	+0 8	5 10
		Mean...	6 11

23rd July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	4 11	+0 9¼	5 8¼
1.	5 1	+0 8¼	5 9¼
2.	5 7	+0 10¼	6 5¼
3.	5 8	+1 2	6 10
4.	5 8	+1 3½	6 11½
5.	7 7	+0 5½	8 0½
6.	7 7½	+0 5	8 0½
7.	7 9	+0 1¾	7 10¾
8.	7 7	−0 0¾	7 6¼
9.	7 8	−0 6¼	7 1¾
10.	7 0	−0 6½	6 5½
11.	6 8	−0 8¼	5 11¾
Midnight.	6 2	−0 7	5 7
13.	5 10	−0 5¾	5 4¼
14.	7 1	−0 10½	6 2½
15.	7 10	−1 1¼	6 8¾
16.	8 0½	−1 0½	7 0
17.	8 3	−0 5¼	7 9¾
18.	8 3	−0 3¾	7 11¼
19.	8 0	−0 1	7 11
20.	7 6	+0 3	7 9
21.	6 9½	+0 8	7 5½
22.	6 0	+0 9½	6 9½
23.	5 5	+0 8½	6 1½
		Mean...	6 11¾

24th July.			
Noon.	5 1	+0 7¾	5 8¾
1.	4 10	+0 11	5 9
2.	5 1	+1 4½	6 5½
3.	5 7	+1 1	6 8
4.	6 3	+0 10	7 1
5.	7 2	+0 5¾	7 7¾
6.	7 8	+0 3	7 11
7.	7 11	+0 0½	7 11½
8.	8 5	−0 4¾	8 0¼
9.	8 3	−0 7½	7 7½
10.	8 1½	−0 11¼	7 2¼
11.	7 0	−0 8	6 4
Midnight.	6 7	−0 7¾	5 11¼
13.	7 6	−1 3½	6 2½
14.	7 7	−1 4	6 3
15.	7 8	−1 2	6 6
16.	7 10	−0 11¾	6 10¼
17.	8 0	−0 7	7 5
18.	8 1	−0 3	7 10
19.	8 0	+0 0½	8 0½
20.	7 9	+0 5	8 2
21.	7 2	+0 8¼	7 10¼
22.	6 6	+1 0	7 6
23.	5 11	+1 0¾	6 11¾
		Mean...	7 1

TABLE I. (continued).

25th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	5 6	+1 1	6 7
1.	5 0	+1 0	6 0
2.	4 9	+1 6	6 3
3.	5 1	+1 4	6 5
4.	5 4	+1 2¾	6 6¾
5.	6 6	+0 8¼	7 2¼
6.	7 6½	+0 2½	7 9
7.	8 3½	−0 2½	8 1
8.	8 9	−0 6	8 3
9.	8 10	−0 8¼	8 1¾
10.	8 11	−1 1¼	7 9¾
11.	9 0	−1 5½	7 6½
Midnight.	8 9	−1 5¾	7 3¼
13.	8 6	−1 8	6 10
14.	7 11	−1 6¼	6 4¾
15.	7 10	−1 2	6 8
16.	7 9	−1 3	6 6
17.	7 9	−0 9	7 0
18.	7 10	−0 1¼	7 8¾
19.	7 9	+0 1¾	7 10¾
20.	7 9	+0 5¾	8 2¾
21.	7 9	+0 6	8 3
22.	6 11	+1 4	8 2
23.	6 3	+1 8¼	7 11¼
		Mean...	7 3¾

26th July.			
Noon.	6 1	+1 8¼	7 9¼
1.	5 4	+1 10¼	7 2¼
2.	4 11½	+1 3	6 2½
3.	4 11	+1 8	6 7
4.	5 2	+1 5¼	6 7¼
5.	6 0	+1 1¾	7 1¾
6.	7 8½	+0 2½	7 11
7.	7 9½	+0 1¼	7 10¾
8.	8 8	−0 3½	8 4½
9.	9 7½	−0 10¾	8 8¾
10.	10 2½	−1 5¼	8 9¼
11.	10 3	−1 8¾	8 6¼
Midnight.	10 2	−1 10¾	8 3¼
13.	9 7	−1 11½	7 7½
14.	7 0	−0 11½	6 0½
15.	8 8	−1 11	6 9
16.	8 4	−1 8¾	6 7¼
17.	8 10	−1 7½	7 2½
18.	8 5	−0 9½	7 7½
19.	8 5	−0 2½	8 2½
20.	8 5	+0 1	8 6
21.	7 11	+0 10¾	8 9¾
22.	7 9	+1 2½	8 11½
23.	7 4	+1 6½	8 10½
		Mean...	7 8½

27th July.			
Time.	Height.	Diurnal Tide.	Semidiurnal Tide.
	ft. in.	ft. in.	ft. in.
Noon.	6 9	+2 4	9 1
1.	6 0	+2 6¾	8 6¾
2.	5 2	+2 0	7 2
3.	4 9	+2 4½	7 1½
4.	4 7	+2 2½	6 9½
5.	5 2	+1 10¾	7 0¾
6.	6 0	+1 4½	7 4½
7.	7 2	+0 10¼	8 0¼
8.	8 6	+0 2½	8 8½
9.	9 10	−0 10	9 0
10.	10 2	−0 10	9 4
11.	10 6	−1 1½	9 4½
Midnight.	12 8	−2 5¾	10 2¼
13.	12 8	−2 10¼	9 9¾
14.	11 4	−2 7½	8 8½
15.	10 4	−2 5¼	7 10¾
16.	9 8	−2 3¾	7 4¼
17.	9 1	−1 10½	7 2½
18.	9 1	−1 6½	7 6½
19.	9 2	−0 10½	8 3½
20.	9 1	−0 2	8 11
21.	9 3	+0 6	9 9
22.	9 3	+0 10½	10 1½
23.	9 1½	...	...
		Mean...	8 5

28th July.			
Noon.	8 8		
1.	7 11		
2.	7 0		
3.	6 2		
4.	5 6		
5.	5 6		
6.	6 1		
7.	7 8		
8.	9 0		
9.	10 8		
10.	11 10		

The mean level of all the Semidiurnal Tide-heights, 538 in number, = 7 ft. 5·414 in.

A. *Diurnal Tide.*

Having obtained the hourly values of the Diurnal Tide in height, I plotted them to scale, and readily obtained the following Table, showing the chief phases of the Diurnal Tide each day.

TABLE II.—Times of the Principal Phases of the Diurnal Tide at Port Kennedy in July 1859.

Time.	High Water.	Half-Ebb.	Low Water.	Half-Flood.
	h m	h m	h m	h m
July 5.	.....	.....	16 40	22 46
6.	5 0	10 20	17 0	21 30
7.	5 0	10 26	15 0	20 48
8.	2 30	8 20	14 0	19 40
9.	1 30	7 0	12 0	18 30
10.	1 30	6 48	13 30	19 25
11.	Noon	8 20	14 30	20 20
12.	2 40	9 0	14 30	20 0
13.	2 30	8 0	15 0	20 30
14.	2 30	8 40	15 30	21 0
15.	3 30	9 20	16 0	21 30
16.	4 0	9 48	16 0	21 45
17.	4 30	10 0	16 30	22 0
18.	4 30	9 30	18 0	23 45
19.	5 40	11 0	17 30	22 40
20.	5 0	10 30	17 0	22 15
21.	5 0	9 40	17 0	21 20
22.	3 0	9 15	16 0	20 30
23.	3 0	7 40	15 0	19 15
24.	2 0	7 10	14 0	18 8
25.	2 0	6 30	13 0	18 30
26.	1 0	7 12	13 30	19 40
27.	1 0	8 10	14 0	20 15

If we extract from this Table the Maximum and Minimum values of the apparent Solitidal Interval for each Phase, and reduce all to the Phase of High Water, we find—

TABLE III.—Maximum apparent Diurnal Solitidal Interval at Port Kennedy in July 1859.

High Water.	Half-Ebb.	Low Water.	Half-Flood.	Apparent Solitidal Interval reduced to High-Water Phase.
d h m	d h m	d h m	d h m	h m s
.....	.....	.....	5 22 46	4 46 0
6 5 0	.....	.....	.....	5 00 0
.....	.....	6 17 0	.....	5 00 0
.....	7 10 26	.....	.....	4 26 0
.....	.....	18 18 0	.....	6 00 0
.....	.....	.....	18 23 45	5 45 0
19 5 40	.....	.....	.....	5 40 0
.....	19 11 0	.....	.....	5 00 0
			Mean ...	5 12 $7\frac{1}{2}$

The Diurnal Tide is represented by the formula

$$D = S' \sin 2\bar{\sigma} \cos(s - i_s) + M' \cos 2\bar{\mu} \cos(m - i_m), \quad \ldots\ldots (2)$$

where the letters have the meaning stated in my former papers, viz.—

S', M' the Solar and Lunar coefficients uncorrected for Parallax;

$\bar{\sigma}$, $\bar{\mu}$ the declinations of the Sun and Moon at an interval preceding the observation called the Age of the Tide;

s, m the Solar and Lunar Hour-angles at the time of observation;

i_s, i_m the true Solitidal and Lunitidal Diurnal Intervals.

The Lunar Tide vanishes when $\mu = 0$; and this corresponds with Table III., which contains the Maximum value of the apparent Solitidal Interval not influenced by the Moon, but representing the full effect of the Sun.

The Moon's declination vanished twice:

From N. to S. at $5^d\,5^h\,11^m$, and
From S. to N. at $19^d\,17^h\,14^m$,

which correspond fairly with the times of Maximum retardation of Solidiurnal Interval. The age of the Lunidiurnal Tide may be found from the interval between the Moon's declination vanishing and the Lunar Tide vanishing, as shown by the Maximum value of the Solitidal Interval. From the first time of tide vanishing we have

	d	h	m
	5	22	46
	6	5	0
	6	17	0
	7	10	26
Mean=	6	13	48
$\mu=0$ at	5	5	11
Age of Lunar Diurnal Tide	1	6	37

From second time of tide vanishing we have

	18	18	0
	18	23	45
	19	5	40
	19	11	0
Mean=	19	2	36
$\mu=0$ at	19	17	14
Age of Lunar Diurnal Tide . . .	00	14	38

From Table III. it appears that the value of i_s, the true Diurnal Solitidal Interval, is

$$i_s = 5^h\,12^m\,7\tfrac{1}{2}^s. \quad \ldots\ldots\ldots\ldots (3)$$

The Minimum values of the apparent Solitidal Intervals, caused by the Maximum influence of the Lunar Tide, are contained in Table IV.

TABLE IV.—Minimum apparent Diurnal Solitidal Interval at Port Kennedy in July 1859.

High Water.	Half-Ebb.	Low Water.	Half-Flood.	Apparent Solitidal Interval reduced to High-Water Phase.
d h m	d h m	d h m	d h m	h m s
.....	.....	9 12 0	.....	0 0 0
.....	.....	.....	9 18 30	0 30 0
.....	10 6 48	.....	.....	0 48 0
11 0 0	.....	.....	.....	0 0 0
.....	.....	.....	24 18 8	0 8 0
.....	25 6 30	.....	.....	0 30 0
.....	.....	25 13 0	.....	0 1 0
26 1 0	.....	.....	.....	0 1 0
			Mean ...	0 29 30

This Table corresponds with the Maximum effect of the Lunar Tide; and the age of Lunar Diurnal Tide may be found by comparing the results of this Table with the times of Maximum of Moon's Declination.

The Moon's Declination attained its Maximum value twice, viz.

	d	h	m		
July	8	10	0	. . . . .	$\mu = 27^\circ\ 43'\ 33''$ S.
„	22	23	0	. . . . .	$\mu = 27\ 43\ 21$ N.

From the first time of Minimum Solitidal Interval in Table IV. we have

	d	h	m
	9	12	0
	9	18	30
	10	6	48
	11	0	0
Mean=	10	3	$19\frac{1}{2}$
μ=Max.	8	10	0
Age of Lunar Diurnal Tide . . .	1	17	$19\frac{1}{2}$

From the second time of Minimum Solitidal Interval we have

	d	h	m
	24	18	8
	25	6	30
	25	13	0
	26	1	0
Mean=	25	9	$39\frac{1}{2}$
μ=Max.	22	23	0
Age of Lunar Diurnal Tide	2	10	$39\frac{1}{2}$

The Mean Age of Lunar Diurnal Tide is therefore

	+1	6	37
	−0	14	38
	+1	17	$19\frac{1}{2}$
	+2	10	$39\frac{1}{2}$
Mean =	1	4	$14\frac{1}{2}$

or, Age of Lunar Diurnal Tide,

$$\begin{matrix} \text{d} & \text{h} & \text{m} \\ =1 & 4 & 14\tfrac{1}{2}. \end{matrix} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

We now proceed to determine the value of the Solar Coefficient S′, which may be readily found as follows:—

We may throw the expression (2) for the Diurnal Tide into the following form, writing

$$S'' = S' \sin 2\bar{\sigma},$$

$$M'' = M' \sin 2\bar{\mu},$$

$$D = A \cos(s - B), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where

$$A = \sqrt{S''^2 + M''^2 + 2S''M'' \cos(\overline{s - m - i_s - i_m}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$\tan B = \frac{S'' \sin i_s + M'' \sin(s - m + i_m)}{S'' \cos i_s + M'' \cos(s - m + i_m)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The Solar Diurnal Tide will occur alone when $M''=0$ or $\bar{\mu}=0$.

The values of A are given from Table I., and are as follows, in Table V.

TABLE V.—Heights of High and Low Water of Diurnal Tide at Port Kennedy in July 1859.

Time.	High Water.	Low Water.	Time.	High Water.	Low Water.
h m	ft. in.	ft. in.	h m	ft. in.	ft. in.
July 5. 17 0.....	.....	1 $9\frac{1}{2}$	July 17. 4 0.....	2 $0\frac{1}{4}$	
6. 5 0.....	1 $5\frac{1}{2}$		17. 16 0.....	.....	1 $11\frac{1}{2}$
6. 17 0.....	.....	1 $4\frac{1}{2}$	18. 5 0.....	1 $7\frac{1}{4}$	
7. 5 0.....	1 $2\frac{1}{4}$		18. 18 0.....	.....	1 7
7. 15 0.....	.....	1 $0\frac{3}{4}$	19. 6 0.....	1 $6\frac{3}{4}$	
8. 2 30.....	1 $0\frac{1}{4}$		19. 17 30.....	.....	1 $4\frac{1}{2}$
8. 14 0.....	.....	1 1	20. 5 0.....	1 $3\frac{1}{2}$	
9. 1 30.....	1 1		20. 17 0.....	.....	1 $3\frac{3}{4}$
9. 12 0.....	.....	1 $2\frac{1}{4}$	21. 5 0.....	1 $1\frac{1}{2}$	
10. 3 0.....	1 2		21. 17 0.....	.....	1 0
10. 13 0.....	.....	1 2	22. 3 0.....	1 $1\frac{1}{2}$	
11. 0 0.....	1 $3\frac{1}{2}$		22. 16 0.....	.....	1 0
11. 13 0.....	.....	1 $6\frac{1}{2}$	23. 3 30.....	1 $3\frac{1}{2}$	
12. 3 0.....	1 11		23. 15 30.....	.....	1 $1\frac{1}{4}$
12. 16 0.....	.....	1 $10\frac{3}{4}$	24. 2 20.....	1 $4\frac{1}{2}$	
13. 4 0.....	2 $2\frac{1}{4}$		24. 14 0.....	.....	1 4
13. 14 0.....	.....	2 $4\frac{3}{4}$	25. 2 30.....	1 6	
14. 2 30.....	2 $5\frac{1}{2}$		25. 13 0.....	.....	1 8
14. 14 30.....	.....	2 $4\frac{1}{4}$	26. 1 0.....	1 $10\frac{1}{4}$	
15. 4 0.....	1 $11\frac{1}{2}$		26. 15 30.....	.....	1 11
15. 16 0.....	.....	1 $7\frac{1}{2}$	27. 1 0.....	2 $6\frac{3}{4}$	
16. 4 0.....	1 $10\frac{1}{2}$		27. 13 0.....	.....	2 $10\frac{1}{4}$
16. 15 30.....	.....	2 $2\frac{1}{2}$			

If we add the age of the Lunar Diurnal Tide to the times of the Moon's Declination vanishing, we shall have the times when $M''=0$:—

	d	h	m		d	h	m
$\mu=0$ . .	5	5	11		19	17	14
Age= . .	1	4	14		1	4	14
	6	9	25		20	21	28

If we take the values of A nearest to these times, from Table V. we find

	ft.	in.		d	h	m
$A=S''=$	1	5	at	6	9	25,
$A=S''=$	1	3	at	20	21	28,

and using the Sun's declination at noon of the day before, we find

$$S'=\frac{S''}{\sin 2\sigma},$$

or

$$S'=\frac{17}{\sin(45^\circ 40')}=23{\cdot}8 \text{ inches},$$

and

$$S'=\frac{15}{\sin(41^\circ 40')}=22{\cdot}6 \text{ inches}.$$

The mean of these values is

$$S'=23{\cdot}4 \text{ inches}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

We can obtain the ratio of M′ to S′ from Tables III. and IV., and thus calculate M′ as follows. Differentiating (7) so as to make B a Maximum or Minimum, we find the equation of condition

$$M''+S''\cos(\overline{s-m}-\overline{i_s-i_m})=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Substituting in (7), we find at the Maximum and Minimum

$$\tan B=\frac{\sqrt{S''^2-M''^2}\sin i_s+M''\cos i_s}{\sqrt{S''^2-M''^2}\cos i_s-M''\sin i_s}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

when $\bar{\mu}=0$, $M''=0$, and the equation reduces to

$$\tan B=\tan i_s, \text{ or } B=i_s,$$

as we assumed in determining the value of the true Diurnal Solitidal Interval from Table III.

If we write

$$\sin\theta=\frac{M''}{S''}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

we can reduce (10) to the following form,

$$\tan B=\tan(i_s+\theta),$$

or

$$B=i_s+\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

The Maximum and Minimum values of B are found from Tables III. and IV.

	h	m	s
B=Maximum=	5	12	$7\frac{1}{2}$,
B=Minimum=	0	29	30;

when B is a Maximum, $M''=0$ and $\theta=0$; therefore (12) reduces to

	h	m	s
$B=i_s=$	5	12	$7\frac{1}{2}$;

when B is a Minimum, equation (12) reduces to

$$\begin{matrix} \text{h} & \text{m} & \text{s} & & \text{h} & \text{m} & \text{s} \\ 0 & 29 & 30 = & & 5 & 12 & 7\tfrac{1}{2}+\theta, \end{matrix}$$

or

$$\theta = -\ 4\ 42\ 37\tfrac{1}{2},$$

or

$$19\ 17\ 22\tfrac{1}{2}.$$

$$\frac{M''}{S''} = \sin(4^{h}\ 42^{m}\ 37\tfrac{1}{2}^{s}) = \sin(70^{\circ}\ 39\tfrac{1}{2}') = 0{\cdot}943;$$

but

$$\frac{M''}{S''} = \frac{M' \sin \overline{2\mu}}{S' \sin \overline{2\sigma}},$$

or

$$\frac{M'}{S'} = \frac{M''}{S''} \cdot \frac{\sin \overline{2\sigma}}{\sin 2\mu} = 0{\cdot}943 \times \frac{\sin 43^{\circ}\,34'}{\sin 55^{\circ}\,27'},$$

or

$$\frac{M'}{S'} = 0{\cdot}788. \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

From (8) and (13) we find

$$M' = 18{\cdot}4 \text{ inches}. \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

From the values already found for the constants of the Solar Diurnal Tide, it was easy to calculate its value, for every hour, from the formula

$$D = S' \sin \overline{2\sigma} \cos(s - i_s).$$

These values, if subtracted from the Diurnal Tide in Table I., would leave the Lunar Diurnal Tide, the principal phases of which are given in the following Table.

TABLE VI.—*Times* of Half-Flood and Half-Ebb, and *Heights* of High Water and Low Water of the Lunar Diurnal Tide at Port Kennedy in July 1859.

	Half-Ebb.	Low Water.	Half-Flood.	High Water.
	h m	ft. in.	h m	ft. in.
July 7.	2 0	0 $5\frac{1}{2}$	13 40	0 $6\frac{1}{2}$
8.	1 50	0 $9\frac{1}{2}$	14 10	1 0
9.	1 30	1 $1\frac{3}{4}$	13 50	1 $2\frac{1}{4}$
10.	2 20	1 $2\frac{1}{4}$	14 0	1 0
11.	1 30	1 3	15 40	1 $3\frac{1}{2}$
12.	6 15	1 $1\frac{3}{4}$	17 25	1 4
13.	5 50	1 $6\frac{1}{4}$	18 25	1 $5\frac{1}{2}$
14.	7 10	1 $5\frac{1}{4}$	19 15	0 8
15.	7 30	0 $8\frac{1}{4}$	20 10	0 8
16.	8 30	0 9	20 45	0 $9\frac{1}{2}$
17.	9 35	0 $7\frac{1}{2}$	21 30	0 4
18.	10 0	——	——	——
19.	——	——	——	——
	Half-Flood.	High Water.	Half-Ebb.	Low Water.
20.	——	——	23 35	0 4
21.	11 50	0 6	——	——
22.	13 10	0 9	0 40	0 $5\frac{1}{2}$
23.	13 0	1 2	1 30	0 $11\frac{3}{4}$
24.	14 30	1 4	2 50	1 $2\frac{1}{2}$
25.	15 40	1 6	3 30	1 4
26.	17 0	1 $7\frac{1}{2}$	4 15	1 $8\frac{1}{4}$
27.	——	——	6 15	1 7

I have used the Times of Half-Flood and Half-Ebb in this Table in preference to the Times of High Water and Low Water, as the vertical motion of the water is a maximum at Half-Flood and Half-Ebb.

Table VI. contains the Solar Hours of Half-Flood and Half-Ebb. These are reduced in the following Table to Lunar Hours.

TABLE VII.—Moon's Hour-Angle at times of Half-Flood and Half-Ebb of Lunar Diurnal Tide at Port Kennedy in July 1859.

Day.	Moon's Hour-Angle at Half-Flood.	Moon's Hour-Angle at Half-Ebb.
	h m	h m
July 7.....	7 15	19 15
8.....	6 45	18 48
9.....	5 38	17 43
10.....	4 59	17 44
11.....	4 9	16 6
12.....	6 36	19 50
13.....	6 43	18 36
14.....	6 34	19 14
15.....	6 51	18 34
16.....	6 42	18 46
17.....	6 46	19 6
18.....	——	18 51
19.....	——	——
20.....	Half-Ebb.	Half-Flood.
21.....	6 10	18 40
22.....	6 29	19 17
23.....	6 29	18 23
24.....	6 53	19 3
25.....	6 34	19 17
26.....	6 15	19 37
27.....	7 9	
	Mean ... 6 23 10^s	18 44 30^s

Hence the mean value of the true Diurnal Lunitidal Interval is at High Water

$$i_m = 0^h\ 33^m\ 50^s. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The coefficient M′, of the Lunar Diurnal Tide, may be found from Heights from Table VI.

The Lunar Diurnal Tide reached its maximum—

d h m	ft. in.
July 13 11 38	1 $6\frac{1}{4}$
July 26 10 3	1 $8\frac{1}{4}$

The Moon's Maximum declination occurred—

d h m	
July 8 10 0 . . .	$\bar{\mu} = 27^\circ\ 43'\ 33''$ S.
July 22 23 0 . . .	„ 27 43 21 N.

These values give for the age of the Lunar Tide deduced from Heights,

	d	h	m
Age of Lunidiurnal Tide . . .	5	1	38
„ „ . . .	3	11	3
Mean . . .	4	6	$20\frac{1}{2}$

This result differs considerably from the age deduced from Times, and agrees with what I have noticed in several tidal observations, viz. that the age of the Tide deduced from Heights is greater than that deduced from Times.

Taking the mean of the Maximum Heights, we have

$$M' = \frac{M''}{\sin 2\mu} = \frac{19{\cdot}25}{\sin 55^\circ\, 27'} = 23{\cdot}37 \text{ inches},$$

$$M' = 23{\cdot}37 \text{ inches}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

and finally, from (8) and (16),

$$\frac{M'}{S'} = \frac{23{\cdot}37}{23{\cdot}4} = 0{\cdot}994. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

If we collect together all the preceding results, we obtain the following:—

Constants of the Diurnal Tide at Port Kennedy in July 1859.

Solar Diurnal Tide.

Age	Unknown.
True Solitidal Interval	$i_s = 5^h\ 12^m\ 7\frac{1}{2}^s$
Coefficient (uncorrected for Parallax) .	$S' = 23{\cdot}4$ inches.

Lunar Diurnal Tide.

Age	$1^d\ 4^h\ 14\frac{1}{2}^m$ (Times).
„	$4^d\ 6^h\ 20\frac{1}{2}^m$ (Heights).
True Lunitidal Interval	$i_m = 0^h\ 33^m\ 50^s$.
Coefficient (uncorrected for Parallax) .	$M' = 18{\cdot}4$ inches (Times).
„ „ „ . .	$M' = 23{\cdot}37$ „ (Heights).
	$\frac{M'}{S'} = 0{\cdot}788$ (Times).
	„ $= 0{\cdot}994$ (Heights).

B. *Semidiurnal Tide.*

From the column of Semidiurnal Tides in Table I. it is easy to construct the following Table:—

TABLE VIII.—Heights and Lunitidal Intervals of Semidiurnal Tide at Port Kennedy in July 1859.

Time.	Heights.		Lunitidal Intervals.	
	High Water.	Low Water.	High Water.	Low Water.
d h m	ft. in.	ft. in.	h m	h m
5 16 30	8 3¼	.....	11 17	
5 23 0	.....	4 2	.....	17 34
6 5 0	8 4½	.....	23 24	
6 11 0	.....	4 3½	.....	5 12
6 17 0	8 3½	.....	11 0	
6 23 30	.....	4 7¼	.....	17 17
7 5 40	8 1½	.....	23 18	
7 12 0	.....	5 1	.....	5 15
7 18 0	8 4¼	.....	11 14	
8 1 0	.....	5 5½	.....	18 0
8 7 0	8 6¼	.....	23 49	
8 13 0	.....	5 8¾	.....	5 37
8 19 30	8 8	.....	12 7	
9 1 30	.....	5 11	.....	17 55
9 8 0	8 11½	.....	24 0	
9 14 0	.....	5 11½	.....	5 48
9 20 0	9 1	.....	11 36	
10 2 0	.....	6 5¾	.....	17 24
10 8 0	9 0½	.....	23 11	
10 14 0	.....	7 2¾	.....	4 59
10 22 0	8 10½	.....	12 43	
11 5 30	.....	7 8¼	.....	19 58
11 10 0	8 11¼	.....	23 44	
11 16 20	.....	7 1¼	.....	5 51
11 23 0	8 10¾	.....	13 11	
12 4 0	.....	6 1¼	.....	18 1
12 11 0	9 1½	.....	23 35	
12 17 0	.....	6 0¾	.....	5 23
12 23 30	9 1¼	.....	12 28	
13 5 30	.....	6 1¾	.....	18 16
13 12 20	9 3	.....	24 50	
13 18 0	.....	6 1¼	.....	6 19
14 1 0	9 5½	.....	13 5	
14 6 30	.....	5 11½	.....	18 24
14 12 0	9 10½	.....	23 42	
14 18 40	.....	5 11	.....	6 9
15 0 0	9 4½	.....	11 18	
15 6 40	.....	5 10	.....	17 45
15 12 0	8 11	.....	22 57	
15 19 0	.....	5 9	.....	5 43
16 1 30	9 2¼	.....	12 0	
16 7 0	.....	5 10½	.....	17 19
16 13 0	9 9	.....	23 12	
16 20 0	.....	5 11½	.....	5 58
17 2 0	9 8¾	.....	11 47	
17 8 0	.....	5 11	.....	17 35
17 14 0	9 9	.....	23 32	
17 20 0	.....	5 11½	.....	5 20
18 2 30	9 5	.....	11 36	
18 9 0	.....	5 10	.....	17 53
18 14 40	9 1½	.....	23 30	
18 21 0	.....	5 8¼	.....	5 37
19 3 0	9 1	.....	11 26	
19 9 0	.....	5 8¼	.....	17 14
19 15 0	9 0¼	.....	23 11	

TABLE VIII. (continued).

Time.	Heights.		Lunitidal Intervals.	
	High Water.	Low Water.	High Water.	Low Water.
d h m	ft. in.	ft. in.	h m	h m
19 21 30	.....	5 10	.....	5 28
20 3 0	9 0	.....	10 47	
20 10 0	.....	5 9½	.....	17 33
20 16 0	8 11	.....	23 30	
20 22 0	.....	5 10	.....	5 18
21 5 0	8 8½	.....	12 4	
21 11 0	.....	5 8½	.....	17 52
21 17 0	8 6	.....	23 47	
21 23 0	.....	5 7	.....	5 35
22 5 0	8 3½	.....	11 24	
22 11 0	.....	5 9	.....	17 12
22 17 30	8 1½	.....	23 33	
23 0 0	.....	5 8¼	.....	5 50
23 5 30	8 0½	.....	11 9	
23 13 0	.....	5 4¼	.....	18 24
23 18 20	7 11¼	.....	23 33	
24 0 20	.....	5 8¾	.....	5 21
24 8 0	8 0¼	.....	12 46	
24 12 0	.....	5 11¼	.....	16 38
24 20 0	8 2	.....	24 17	
25 1 0	.....	6 0	.....	5 7
25 7 0	8 3	.....	10 55	
25 14 0	.....	6 4¾	.....	17 41
25 21 20	8 3	.....	24 36	
26 2 0	.....	6 2½	.....	5 7
26 9 40	8 9¼	.....	12 31	
26 14 0	.....	6 0½	.....	16 51
26 21 0	9 1	.....	24 46	
27 4 0	.....	6 9½	.....	7 32
27 12 0	10 2¼	.....	13 45	
27 17 0	.....	7 2½	.....	18 35

From this Table we find :—

Mean of Lunitidal Intervals.

	h	m	s
43 High Waters	23	48	58½
43 Low Waters reduced to phase of High Water .	23	43	1⅓
Mean Lunitidal Interval	23	46	0

Mean Height.

	ft.	in.
High Water	8	10·55
Low Water	5	10·98

The Maximum and Minimum Ranges in height were as follows :—

	d	h	m	ft.	in.
Maximum Range	6	2	0	4	1½
,, ,, ...	14	15	20	3	11½
				4	0½

	d	h	m	ft.	in.
Minimum Range	11	3	45	1	$2\frac{1}{4}$
„ „	25	17	40	2	2
				1	$8\frac{1}{8}$

Hence we have, if M'' and S'' represent the Lunar and Solar Semidiurnal Coefficients, uncorrected for Declination and Parallax,

$$2(M''+S'')=48.$$
$$2(M''-S'')=20.$$
$$M''=17 \text{ inches.}$$
$$S''=7 \text{ „}$$
$$\frac{M''}{S''}=0{\cdot}412. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

Table IX. contains the Times and Lunitidal Intervals of Half-Flood and Half-Ebb, determined from Table I., from the moment at which the water-level passed the mean height of Tide-level, as noted at foot of column 4, for each day.

TABLE IX.—Times and Lunitidal Intervals of Half-Flood and Half-Ebb of Semidiurnal Tide at Port Kennedy in July 1859.

	Times.		Lunitidal Intervals.	
	Half-Flood.	Half-Ebb.	Half-Flood.	Half-Ebb.
	h m	h m	h m	h m
July 5.	13 45	.....	8 37	
5.	.....	18 56	.....	13 38
6.	1 46	.....	20 16	
6.	.....	7 51	.....	1 12
6.	14 14	.....	8 29	
6.	.....	20 17	.....	14 11
7.	2 50	.....	20 35	
7.	.....	8 38	.....	2 11
7.	14 56	.....	8 17	
7.	.....	21 45	.....	14 52
8.	3 50	.....	20 50	
8.	.....	9 48	.....	2 37
8.	16 7	.....	8 43	
8.	.....	22 49	.....	14 47
9.	4 48	.....	20 54	
9.	.....	11 22	.....	3 15
9.	16 54	.....	8 37	
10.	.....	0 13	.....	15 40
10.	5 47	.....	21 3	
10.	.....	12 25	.....	3 27
10.	18 26	.....	9 8	
11.	.....	1 22	.....	15 58
11.	7 29	.....	21 49	
11.	.....	13 33	.....	3 41
11.	21 3	.....	10 57	
12.	.....	2 37	.....	16 9
12.	7 4	.....	21 36	

TABLE IX. (continued).

	Times.		Lunitidal Intervals.	
	Half-Flood.	Half-Ebb.	Half-Flood.	Half-Ebb.
	h m	h m	h m	h m
July 12.	.....	14 41	.....	3 57
12.	19 48	.....	8 53	
13.	.....	2 28	.....	15 20
13.	8 36	.....	21 14	
13.	.....	15 13	.....	3 37
13.	20 56	.....	9 10	
14.	.. ...	2 47	.....	14 49
14.	9 48	.....	21 34	
14.	.....	15 12	... ..	2 48
14.	22 2	.....	9 24	
15.	.....	3 58	.....	15 8
15.	9 37	.....	20 39	
15.	.....	15 53	.....	2 42
15.	21 41	.....	8 19	
16.	.....	4 12	.....	14 36
16.	9 53	.....	20 13	
16.	.....	16 50	.....	2 55
16.	22 50	.....	8 52	
17.	.....	5 7	.....	14 48
17.	11 14	.....	20 50	
17.	.....	17 21	.....	2 45
17.	22 56	.....	8 9	
18.	.....	5 42	.....	14 41
18.	11 36	.....	20 33	
18.	.....	17 53	.....	2 36
18.	23 52	.....	8 24	
19.	.....	6 16	.....	14 35
19.	12 15	.....	20 32	
19.	... ..	18 28	.....	2 32
20.	0 25	.....	8 17	
20.	.....	6 43	.....	14 23
20.	12 53	.....	20 29	
20.	.....	18 58	.....	2 22
21.	0 58	.....	8 10	
21.	.....	7 24	.....	14 24
21.	13 37	.....	20 27	
21.	.....	19 23	.....	2 5
22.	1 28	.....	7 58	
22.	.....	7 59	.....	14 16
22.	14 13	.....	20 22	
22.	.....	20 31	.....	2 28
23.	4 1	.....	9 43	
23.	.....	9 13	.....	14 44
23.	15 50	.....	21 8	
23.	.....	21 43	.....	2 50
24.	4 0	.....	8 54	
24.	.....	10 9	.....	14 51
24.	16 24	.....	20 49	
24.	.....	22 48	.....	3 1
25.	5 13	.....	9 13	
25.	.....	11 50	.....	15 37
25.	17 27	.....	19 49	
26.	.....	0 7	.....	3 17
26.	5 44	.....	8 44	
26.	.....	12 53	.....	16 1
26.	18 8	.....	20 29	
27.	.....	1 6	.. ...	3 12
27.	7 34	.....	9 28	
27.	....	14 21	.....	16 1
27.	19 11	.....	20 37	

From this Table we find :—

	h	m	s
Mean Lunitidal Interval of 44 Half-Floods . . .	20	45	19
„ „ 43 Half-Ebbs . . .	2	54	24

Reducing the Lunitidal Intervals found from Tables VIII. and IX. to the phase of High Water, we have

Mean Lunitidal Interval $=i_m$.

	h	m	s
From High Waters	23	48	58
„ Low Waters	23	43	1
„ Half-Floods	23	45	19
„ Half-Ebbs	23	54	46
Mean	23	48	1

$$\left.\begin{array}{rrrr} & \text{h} & \text{m} & \text{s} \\ i_m = & 23 & 48 & 1 \\ \text{or} - & 0 & 11 & 59 \end{array}\right\} \quad \ldots\ldots\ldots\ldots \quad (19)$$

We may calculate the ratio of the Solar and Lunar Semidiurnal Tides from Tables VIII. and IX. by the following method :—

$$\text{Let } \mathrm{M}''=\mathrm{M}\left(\frac{\mathrm{P}}{\mathrm{P}_m}\right)^3\cos^2\bar{\mu},$$

$$\mathrm{S}''=\mathrm{S}\left(\frac{p}{p_m}\right)^3\cos^2\bar{\sigma},$$

where P, p are the parallax of the Moon and Sun, taken at an interval before the observation equal to the age of the respective Tides; and P_m, p_m are the mean values of same.

Then if the Semidiurnal Tide be

$$\mathrm{T}=\mathrm{M}''\cos 2\,(m-i_m)+\mathrm{S}''\cos 2\,(s-i_s), \quad \ldots\ldots\ldots \quad (20)$$

we may write (20) thus,

$$\mathrm{T}=\mathrm{A}\cos 2\,(m-\mathrm{B}), \quad \ldots\ldots\ldots\ldots\ldots \quad (21)$$

where

$$\mathrm{A}=\sqrt{\mathrm{M}''^2+\mathrm{S}''^2+2\mathrm{M}''\,\mathrm{S}''\cos 2\,[\overline{m-s}-\overline{i_m-i_s}]}, \quad \ldots \quad (22)$$

$$\tan 2\mathrm{B}=\frac{\mathrm{M}''\sin 2i_m+\mathrm{S}''\sin 2\,[m-s+i_s]}{\mathrm{M}''\cos 2i_m+\mathrm{S}''\cos 2\,(m-s+i_s)}. \quad \ldots\ldots\ldots \quad (23)$$

The Maximum and Minimum values of A are $\mathrm{M}''+\mathrm{S}''$ and $\mathrm{M}''-\mathrm{S}''$, as used in finding (18); and the Maximum and Minimum values of B are found by differentiating (23), which gives, as the equation of condition,

$$\mathrm{S}''+\mathrm{M}''\cos 2\,(\overline{m-s}-\overline{i_m-i_s})=0. \quad \ldots\ldots\ldots \quad (24)$$

Combining (23) and (24) we find, after a few reductions,

$$\tan 2B = \frac{\sqrt{M''^2 - S''^2}\sin 2i_m + S''\cos 2i_m}{\sqrt{M''^2 - S''^2}\cos 2i_m - S''\sin 2i_m}. \quad \ldots\ldots\ldots \quad (25)$$

If we assume

$$\frac{S''}{M''} = \sin 2\phi,$$

the equation (25) will reduce to the following:—

$$\tan 2B = \tan 2(\phi + i_m),$$

or

$$B = \phi + i_m. \quad \ldots\ldots\ldots \quad (26)$$

The Maximum and Minimum values of B, or of the Lunitidal Interval, are found from Tables VIII. and IX., and are as follows:—

Maximum Values of Lunitidal Interval.

	h	m	s		d	h	m
High Water	25	5	0	at	14	1	0
,,	24	46	0	,,	26	21	0
Low Water	25	58	0	,,	11	5	30
,,	24	35	0	,,	27	17	0
Half-Flood	25	57	0	,,	11	21	3
,,	24	28	0	,,	27	7	34
Half-Ebb	25	9	0	,,	12	2	37
,,	25	1	0	,,	27	14	21
Mean=	25	7	$22\frac{1}{2}$				

Minimum Values of Lunitidal Interval.

	h	m	s		d	h	m
High Water	23	0	0	at	6	17	0
,,	22	55	0	,,	25	7	0
Low Water	23	12	0	,,	6	11	0
,,	22	38	0	,,	24	12	0
Half-Flood	23	16	0	,,	6	1	46
,,	22	58	0	,,	22	1	28
Half-Ebb	22	12	0	,,	6	7	51
,,	23	5	0	,,	21	19	23
Mean=	22	54	0				

From equation (26) we see that the value of B ranges above and below that of i_m by

a quantity equal to φ, which is half the difference between the maximum and minimum values of B. Hence we find

		h	m	s
Maximum value of B	=	25	7	$22\frac{1}{2}$
Minimum „ „	=	22	54	0
2φ	=	2	13	$22\frac{1}{2}$

$$2\varphi = 33^\circ\ 20\tfrac{1}{2}'.$$

$$\frac{M''}{S''} = \sin 2\varphi = 0{\cdot}549. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

Collecting together the foregoing results, we have the following

Constants of the Semidiurnal Tide at Port Kennedy in July 1859.

Lunar Semidiurnal Tide.

True Lunitidal Interval	$23^h\ 48^m\ 1^s$.
Ratio of $\frac{S''}{M''}$	0·412 (Heights). 0·549 (Times).

(Uncorrected for Declination or Parallax.)