

TIDAL AND GENERAL NOTES ON CATTEWATER.

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I AM indebted to Major Daubeny for the opportunity of examining an interesting MS. written in 1839 by a certain "J. B.," then residing at Stonehouse, and who from internal evidence as well as external was Mr. Blackburne, for some years lessee of the dock at Turnchapel, and the author of certain plans for the improvement of Sutton Pool, referred to in Burt's *Commerce of Plymouth*. Some of the notes contained in this MS. are of considerable value, especially those upon the tides at Plymouth, based upon a series of observations "carefully" made "and registered at Turnchapel in the harbour of Catwater during the several years of 1803, 1804, and 1805. This was about nine years before the first stone of the Breakwater in Plymouth Sound was deposited." The important portions of these observations are embodied in the following extracts:

"The two spring tides of each lunation flow to an unequal height, or one rises higher than the other, and there is a periodical alteration of when the highest of these two spring tides takes place. At one time of the year the full moon spring tides are higher than those of the new moon. At another time of the year the new moon spring tides are higher than those of the full moon. This alteration takes place at the winter and summer solstices. From January to July the new moon spring tide is the highest, and from July to January the full moon spring tide is the highest. The best spring tide rises 9 inches higher than the other, and falls 13 inches lower than the other. There is also a difference in the height of the rise of the tides in the morning and evening, and there is also a periodical alteration in this respect, which takes place at the spring and autumnal equinoxes. The morning tides are higher than the evening tides between September and March, and the evening tides are the highest between March and September. The tides are fifteen minutes longer in falling than in flowing.

"A north-east wind occasions the least rise and the lowest fall

in the tides, and a south by west wind causes the highest rise and the least fall. A sudden increase in the density of the air . . . will diminish, check, or nip the rise of the tides. When there is a rise of one inch in the quicksilver, if such rise is sudden and rather local, the height of the tide at high water will in proportion be twelve inches less. It is a popular notion that frosts nip the tides, and it has been commonly observed that during a sharp frost the tides do not rise so high . . . the actual cause is the additional pressure of the atmosphere . . . the barometer usually ranging high during severe frosts.

"The same observation applies, only with a contrary effect, when the barometer falls suddenly . . . the tide in consequence rises so much the higher, and in the proportion before stated of one inch fall in the quicksilver to twelve inches increase in the rise of the tides.

"Whenever a new moon or a full moon occurs on or about the day of the spring or autumnal equinoxes, and the moon chances to be in apogee at the juncture, and two of the superior planets in ecliptic conjunction with her also, the quicksilver very low, and a hard gale from the south and by west blowing at the time, this port is sure to be visited by a very extraordinary inundating high tide—a tremendous flow of waters."

RISE AND FALL OF THE WATER AT THE BEST OR HIGHEST SPRING TIDES.

Moon's Age,	Time of High Water.	Time of Low Water.	Rise and fall of the Tides perpendicularly.	How much the water flows higher than at Neap Tides.	How much the water falls lower than at Neap Tides.
	h. m.	h. m.	ft. in.	ft. in.	ft. in.
Day of full and change	4.48 a.m.	11.6 a.m.	14 10	4 6	3 4
1st day after	5.28 "	11.47 "	15 9	4 9	4 0
2nd "	6.6 "	12.25 p.m.	14 0	3 10	3 2
3rd "	6.49 "	1.8 "	13 4	3 6	2 10
4th "	7.29 "	1.48 "	12 9	3 3	2 6
5th "	8.11 "	2.30 "	11 8	3 0	1 8
6th "	8.58 "	3.19 "	10 4	2 6	10
7th "	9.51 "	4.12 "	8 7	1 6	1
8th "	10.46 "	5.11 "	7 6	6	0
9th "	11.47 "	6.17 "	7 0	Dead of the Neaps.	
10th "	12.58 p.m.	7.26 "	7 1	0	1
11th "	2.7 "	8.31 "	8 4	1 2	2
12th "	3.6 "	9.26 "	9 7	1 9	10
13th "	3.54 "	10.12 "	10 9	2 3	1 6
14th "	4.30 "	10.48 "	12 1	2 10	2 3

RISE AND FALL OF THE WATER AT THE WORST SPRING TIDES.

Moon's Age.	Time of High Water.	Time of Low Water.	Rise and fall of the Tides perpendicularly.	How much the water flows higher than at Neap Tides.	How much the water falls lower than at Neap Tides.
Day of full and change	h. m.	h. m.	ft. in.	ft. in.	ft. in.
1st day after	4.48 a.m.	11.6 a.m.	13 1	1 11	2 9
2nd "	5.28 "	11.47 "	13 11	2 7	2 11
3rd "	6.6 "	12.25 p.m.	13 6	2 7	2 6
4th "	6.49 "	1.8 "	13 2	2 7	2 2
5th "	7.29 "	1.48 "	12 4	2 3	1 8
6th "	8.11 "	2.30 "	11 2	1 11	10
7th "	8.58 "	3.19 "	10 6	1 7	6
8th "	9.51 "	4.12 "	9 5	9	3
9th "	10.46 "	5.11 "	8 9	4	0
10th "	11.47 "	6.17 "	8 5	Dead of the Neaps.	
11th "	12.58 p.m.	7.26 "	9 9	6	10
12th "	2.7 "	8.31 "	10 10	1 1	1 4
13th "	3.6 "	9.26 "	12 1	1 7	2 1
14th "	3.54 "	10.12 "	13 1	2 1	2 7
15th "	4.30 "	10.48 "	13 10	2 7	2 10

Mr. Blackburne has also recorded some interesting notes touching the encroachment of the sea at Mount Batten. For several years he occupied the field there as a place for laying timber. On the side of the field next the Sound the Admiralty had placed three upright stones "along the lowest part of the field, not far from the edge of the cliff . . . with a view to ascertain the actual progress of the encroachment of the sea on the low neck of land in times to come. Fears were in fact entertained for the ultimate security of the harbour of Catwater, many acres having been washed away to the south-east of the old sea wall within the memory of man, and the soil being at length washed away from behind the sea wall. The wall itself from being thus left exposed to the depredation of the sea at high tides gradually yielded to it, and a great part of it had at the juncture been entirely washed away."

On the 24th December, 1807, Mr. Blackburne carefully measured the distances from the edge of the cliff to each of these stones. The distance from the edge to the north-westernmost stone was then 39 feet; to the middle stone 37 feet 6 inches; to the south-easternmost stone 26 feet 6 inches. Twenty-six years subsequently,

September 6th, 1833, he found the distances to have decreased 4 feet at the north-westernmost stone, 3 feet 6 inches at the middle stone, and at the southernmost stone 9 feet 6 inches—the measured distances being respectively 35 feet, 34 feet, and 17 feet. “I observed also,” he adds, “that in the course of these years nearly as much of the sea wall had been washed away as was left standing. In the course of time it will all go, and the low land be left to the mercy of the sea, the water at length make a breach over it, and eventually it may become similar to the bridge between Nicholas Island and Mount Edgcumbe.”

Mr. Blackburn's prophecy has not been fulfilled, nor does it now seem likely to be. The completion of the Breakwater a few years later than his last observation has apparently removed all danger from that side; and it is not at all unlikely that the greater part of the waste he records had taken place in the earlier years of the period, before the Breakwater had begun to afford protection. The waste since 1833 cannot at any rate have been very serious, though its exact amount is not definitely ascertainable, and there is only a small fragment of the wall now (1887) left. Such encroachments as have taken place of late on the seaward face of the isthmus appear to be of a local and casual character. On the other hand there is ample evidence that a good deal of the low earthen cliff on the Cattewater side has been gradually wasted by the tide undermining the bank, and that this process is still in operation.

The bulk of Mr. Blackburne's MS. is occupied with a description of the Turnehapel Dock and the means adopted to make it watertight and available for occupation, the original arrangement being most defective. Probably the most practically interesting part in a scientific point of view is the description given of the rock in which it was excavated. From the head, half way toward the dock gates, it was cut out of schistose rock in which were numerous fissures pervious to water, containing loose soil and decayed slate. Further north, on the east in particular, there was loose slate. The ground under the apron was a sort of clay mixed with small pieces of decayed slate, and there was a good depth of it, excepting at and near the western pier, where the slate rock approached. The schistose rock was bounded both north and south by limestone. At about 60 feet from the head of the dock southward it joined the limestone, and at about 200 feet from the

dock gates north-easterly limestone commenced again. "The northern side of the yard was once a steep lofty rock, high as a ship's masthead, and at its foot, about where the south building-slip now is, and toward the next slip, was a low neck of land across which the sea used to flow over at spring tides. The lofty rock being limestone of a different period of formation to any in the neighbourhood, and superior in quality to any thereabouts, it was in lapse of time all quarried away down to its present level."