

inside of the Hook extending nearly one-third of the distance across Sandy Hook Bay. These currents run to the north, during both the ebb and flood tide, with varying rates, and result from those tides directly and indirectly. The inner current is the one by which the flood and ebb tides draw, by the lateral communication of motion, the water from Sandy Hook Bay, and the outer is similarly related to those tides as they pass False Hook channel. The velocities and directions found, favor this conclusively.

An important observation for navigation results from this, for eleven hours out of the twelve, there is a northwardly current running through False Hook channel, which assists vessels entering New York harbor on the ebb tide, and is to be avoided in passing out with the ebb.

It is the conflict of these two northwardly currents outside and inside, and the deposit of the materials which they carry to the point of the Hook, which causes its growth.

Within a century it has increased a mile and a quarter, and at about the rate of one sixteenth of a mile a year, on the average, for the last twelve years.

Flynn's Knoll, on the north side of the main ship channel, does not give way, as the point of the Hook advances. The importance of watching this movement cannot, therefore be over stated.

The mode of controlling the growth is obvious from the result obtained. The observations are still continued, to obtain the necessary numerical results.

APPROXIMATE COTIDAL LINES OF DIURNAL AND SEMI-DIURNAL TIDES OF THE COAST OF THE UNITED STATES ON THE GULF OF MEXICO—BY A. D. BACHE, SUPERINTENDENT UNITED STATES COAST SURVEY. COMMUNICATED BY AUTHORITY OF THE TREASURY DEPARTMENT.

This paper is supplementary to those on cotidal lines of the Atlantic and Pacific coasts heretofore communicated to the Association. Preparation was made at the last meeting for these conclusions by presenting the type curves of the Gulf coast. The tides from Cape Florida to St. George's are of the usual type, with a large daily inequality. From St. George's to the mouth of the Mississippi they are of the single day type. Then the half-day tides reappear to extend beyond Galveston, the day tides recurring at Aransas, in Texas, and southward. When the type curves were presented, the mode of decomposing them with a diurnal and semi-diurnal wave was described. The tide stations extend along our whole coast, but observations are much wanted beyond it to complete the investigation, on the south side of the Straits of Florida, on the eastern coast of the Gulf of Mexico south of Texas, and especially between Cuba and Yucatan, at the entrance of the Gulf from the Caribbean sea.

A table of the stations at which the observations were made, of the heights of tide (rise and fall) observed, and of the half-day and day tides, was given; and another showing the period of observation and the name of the observer. The first table is represented on a diagram by which a navigator may find the rise and fall of tide approximately on any part of our Gulf coast. The least observed rise and fall is at Brazos Santiago, Texas, and is nine tenths of a foot. The greatest is at Cedar keys, Florida, and is two and a half feet. The difficulties of the problem presented by these tides are explained, removable in part by the progress of the survey of the Gulf, inherent in them in part. The labors of Mr. Pourtales and other gentlemen concerned in the discussion of these tides are acknowledged. The single-day tides have not been so elaborately discussed by former physicists or mathe-