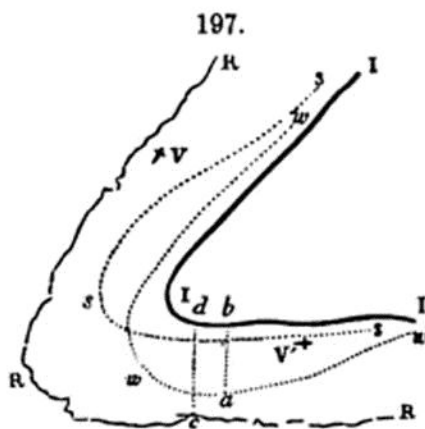


vessel pursued the same course. Again, an anchor with 10 fathoms of chain attached, from a brig of 200 tons wrecked on Cape Cod near Truro, was drifted a mile and a half to the north in three weeks. These facts are from papers by Lieutenant C. H. Davis (1849, 1851). Such transportation is beyond the power of any currents; it is the work of the dashing, lifting, and propelling waves.

In the following example, the change of position is connected with a change in the seasons. J. D. Hague states that at Baker Island (of coral), in the Pacific ($0^{\circ} 15' N.$, $176^{\circ} 22' W.$), this fact is well exhibited. In Fig. 197, I, I, I is the southwest point of the island, and R, R, R, the outline of the coral-reef platform, mostly a little above low-tide level; its width, *cd*, 100 yards. In the summer season, when the wind is from the southeast, the beach has the outline *s, s, s*; during the winter months, when the wind is northeast, the material is transferred around the point, and has the position *w, w, w*, having a width at *ab* of 200 feet. A vessel wrecked in summer, and stranded at *V*, was transferred to *V'* in the course of the month of November. (J. D. Hague, '62.)



6. *Sand-bars at the entrances of harbors or mouths of tidal rivers.* — The material of the sand-bars which obstruct the entrances of harbors has two main sources: an inner, and an outer; the former *fluvial*, the latter the *wave-and-current driftings* of the coast, which contribute so largely to sand-barriers. The positions of the bars depend much on the strength of the river current; but also on the direction, form, and supplies of the wave-and-current movement produced by the storm-winds. A small stream is often blocked entirely by a sand-bar across its mouth, so that the waters reach the ocean only by percolation through the beach. But large streams make distant sand-reefs or barriers through the aid of the outflow, and keep open channels even in the face of the ocean.

The depth of water over the sand-bars at the mouth of a large river or bay is, in great part, only 3 to 10 feet: a remarkable fact, considering the opposing forces at work — the tidal outflow and inflow, and the plunge of the storm-made waves over the mobile sands. The sands lie along the area of rest between the contesting movements. New York Bay (map, page 211) affords an example. The contributions of river sediment come from the Hudson River and from small New Jersey rivers; and the Hudson is moderate in its supplies, considering its length and size, because it has almost no tributaries for 60 miles, and small ones for 100 miles, owing to the westward dip of the Catskill strata and the barrier of the Palisades in the southern part. The wave-and-current supplies come from the direction of the Long Island and the New Jersey coasts; for New York Bay is exceptional in lying to the *leeward* of both coasts. Under these circumstances, Sandy Hook, the sand-bars, and the barriers of the Long Island coast adjoining, have been accumulated. The outlining of the bars, and the positions of the three channels through them, are mainly due to the tidal outflow, which