

CHAPTER XV.

Destroying and transporting effects of tides and currents—Shifting of their position—Differences in the rise of the tides—Causes of currents—Action of the sea on the British coast—Shetland Islands—Large blocks removed—Effects of lightning—Breach caused in a mass of porphyry—Isles reduced to clusters of rocks—Orkney Isles—East coast of Scotland—Stones thrown up on the Bell Rock—East coast of England—Waste of the cliffs of Holderness, Norfolk, and Suffolk—Silting up of estuaries—Origin of submarine forests—Yarmouth estuary—Submarine forests—Suffolk coast—Dunwich—Essex coast—Estuary of the Thames—Goodwin Sands—Coast of Kent—Formation of Straits of Dover—Coast of Hants—Coast of Dorset—Portland—Origin of the Chesel Bank—Cornwall—Lionnesse tradition—Coast of Brittany.

ALTHOUGH the movements of great bodies of water, termed tides and currents, are in general due to very distinct causes, we cannot consider their effects separately, for they produce, by their joint action, those changes which are subjects of geological inquiry. We may view these forces as we before considered rivers, first, as employed in destroying portions of the solid crust of the earth, and removing them to other localities; secondly, as reproductive of new strata. Some of the principal currents which traverse large regions of the globe depend on permanent winds, and these on the rotation of the earth on its axis, and its position in regard to the sun:—they are causes, therefore, as constant as the tides themselves, and, like them, depend on no temporary or accidental circumstances, but on the laws which preside over the motions of the heavenly bodies. But, although the sum of their influence in altering the surface of the earth may be very constant throughout successive epochs, yet the points where these operations are displayed in the fullest energy shift perpetually. The height to which the tides rise, and the violence and velocity of currents, depend in a great measure on the actual configuration of the land, the contour of a long line of continental or insular coast, the depth and breadth of channels, the peculiar form of the bottom of seas—in a word, on a combination of circumstances which are made to vary continually by many igneous and

aqueous causes, and, among the rest, by tides and currents. Although these agents, therefore, of decay and reproduction, are local in reference to periods of short duration, such as those which history in general embraces, they are nevertheless universal, if we extend our views to a sufficient lapse of ages.

The tides, as is well known, rise in certain channels, bays, and estuaries, to an elevation far above the average height of the same tides in more open parts of the coast, or on islands in the main ocean. In all lakes, and in most inland seas, the tides are not perceptible. In the Mediterranean, even, deep and extensive as is that sea, they are only sensible in certain localities, and they then rarely rise more than six inches above the mean level. In the Straits of Messina, however, there is an ebb and flow every six hours, to the amount of two feet, but this elevation is partly due to the peculiar set of the currents. In islands remote from the shore, the rise of the tides is slight, as at St. Helena, for example, where it rarely exceeds three feet *. In the estuary of the Severn, the rise at King's Road near Bristol is forty-two feet; and at Chepstow on the Wye, a small river which opens into the same estuary, about fifty feet. All the intermediate elevations may be found at different places on our coast. Thus, at Milford Haven, the rise is thirty-six feet; at London, and the promontory of Beachy Head, eighteen feet; at the Needles, in the Isle of Wight, nine feet; at Weymouth, seven; at Lowestoff about five; at Great Yarmouth, still less.

That movements of no inconsiderable magnitude should be impressed on an expansive ocean, by winds blowing for many months in one direction, may easily be conceived, when we observe the effects produced in our own seas by the temporary action of the same cause. It is well known that a strong south-west or north-west wind, invariably raises the tides to an unusual height along the east coast of England, and in the Channel; and that a north-west wind of any continuance causes the Baltic to rise two feet and upwards above its ordinary level. Smeaton ascertained, by experiment, that in a canal four miles in length, the water was kept up four inches higher at one end than at the other, merely by the action of the wind along the canal; and Rennel informs us, that a large piece

* Romme, *Vents et Courans*, vol. ii., p. 2. Rev. F. Fallows, *Quart. Journ. of Sci.*, March, 1829.

of water, ten miles broad, and generally only three feet deep, has, by a strong wind, had its waters driven to one side, and sustained so as to become six feet deep, while the windward side was laid dry*. As water, therefore, he observes, when pent up so that it cannot escape, acquires a higher level, so, in a place *where it can escape*, the same operation produces a current; and this current will extend to a greater or less distance, according to the force by which it is produced. The most extensive and best determined of all currents, is the gulf stream, which sets westward in tropical regions; and, after doubling the Cape of Good Hope, where it runs nearly at the rate of two miles an hour, inclines considerably to the northward, along the western coast of Africa, then crosses the Atlantic, and, having accumulated in the Gulf of Mexico, passes out at the Straits of Bahama, with a velocity of four miles an hour, which is not reduced to two miles until the stream has proceeded to the distance of eighteen hundred miles in the direction of Newfoundland: near that island it meets with a current setting southward from Baffin's Bay, on the coast of Greenland, and is thereby deflected towards the east. One branch extends in that direction, while another runs towards the north; so that fruits, plants, and wood, the produce of America and the West Indies, are drifted to the shores of Ireland, the Hebrides, and even to Spitzbergen.

In describing the destroying effects of tides and currents, it will be necessary to enter into some detail, because we have not the advantage here, as in the case of the deltas of many rivers, of viewing the aggregate mass which has resulted from the continual transportation of matter, for many centuries, at certain points. We must infer the great amount of accumulation as a corollary from the proofs adduced of the removing force; and this it will not be difficult to show is, on the whole, greater than that of running water on the land.

If we follow the eastern and southern shores of the British islands, from our Ultima Thule in Shetland, to the Land's End in Cornwall, we shall find evidence of a series of changes since the historical era, very illustrative of the kind and degree of force exerted by the agents now under consideration. In this survey we shall have an opportunity of tracing the power of the sea on islands, promontories, bays, and estuaries; on bold,

* Rennel on the Channel-current.

lofty cliffs as well as on low shores ; and on every description of rock and soil, from granite to blown sand. We shall afterwards explain by reference to other regions, some phenomena of which our own coast furnishes no examples.

Shetland Islands.—The northernmost group of the British islands, the Shetland, are composed of a great variety of primary and trap rocks, including granite, gneiss, mica-slate, serpentine, greenstone, and many others, with some secondary rocks, chiefly sandstone and conglomerate. These isles are exposed continually to the uncontrolled violence of the Atlantic, for no land intervenes between their western shores and America. The prevalence, therefore, of strong westerly gales, causes the waves to be sometimes driven with irresistible force upon the coast, while there is also a current setting from the north. The spray of the sea aids the decomposition of the rocks, and prepares them to be breached by the mechanical force of the waves. Steep cliffs are hollowed out into deep caves and lofty arches ; and almost every promontory ends in a cluster of rocks, imitating the forms of columns, pinnacles, and obelisks. Modern observations show that the reduction of continuous tracts to such insular masses is a process in which Nature is still actively engaged. “ The Isle of Stennes,” says Dr. Hibbert, “ presents a scene of unequalled desolation. In stormy winters, huge blocks of stones are overturned, or are removed from their native beds, and hurried up a slight acclivity to a distance almost incredible. In the winter of 1802, a tabular-shaped mass, eight feet two inches by seven feet, and five feet one inch thick, was dislodged from its bed, and removed to a distance of from eighty to ninety feet. I measured the recent bed from which a block had been carried away the preceding winter (A. D. 1818), and found it to be seventeen feet and a half by seven feet, and the depth two feet eight inches. The removed mass had been borne to a distance of thirty feet, when it was shivered into thirteen or more lesser fragments, some of which were carried still farther, from thirty to one hundred and twenty feet. A block, nine feet two inches by six feet and a half, and four feet thick, was hurried up the acclivity to a distance of one hundred and fifty feet*.”

* Dr. Hibbert, Description of the Shetland Islands, p. 527. Edin., 1822.

At Northmavine, also, angular blocks of stone have been removed in a similar manner to considerable distances, by the waves of the sea*, some of which are represented in the annexed figure, No. 7.



Stony fragments drifted by the sea. Northmavine, Shetland.

In addition to numerous examples of masses detached and driven by the tides and currents from their place, some remarkable effects of lightning are recorded in these isles. At Funzie, in Fetlar, about the middle of the last century, a rock of mica schist, one hundred and five feet long, ten feet broad, and in some places four feet thick, was in an instant torn by a flash of lightning from its bed, and broken into three large, and several lesser fragments. One of these, twenty-six feet long, ten feet broad, and four feet thick, was simply turned over. The second, which was twenty-eight feet long, seventeen broad, and five feet in thickness, was hurled across a high point to the distance of fifty yards. Another broken mass, about forty feet long, was thrown still farther, but in the same direction, quite into the sea. There were also many lesser fragments scattered up and down †.

When we thus see electricity co-operating with the violent movements of the ocean in heaping up piles of shattered rocks on dry land, and beneath the waters, we cannot but admit that a region which shall be the theatre, for myriads of ages, of the action of such disturbing causes, will present, at some future period, a scene of havoc and ruin that may compare with any

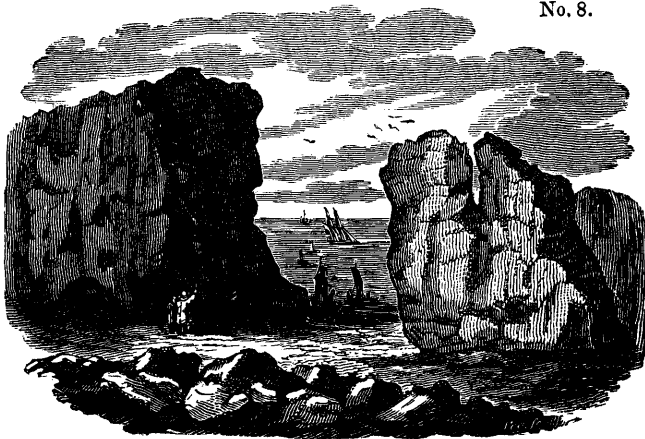
* For this and the three following representations of rocks in the Shetland Isles, I am indebted to Dr. Hibbert's work before cited, which is rich in antiquarian and geological research.

† Dr. Hibbert, from MSS. of Rev. George Low, of Fetlar.

now found by the geologist on the surface of our continents ; raised as they all have been in former ages from the bosom of the deep. We have scarcely begun, as yet, to study the effects of a single class of the mighty instruments of change and disorder now operating on our globe ; and yet geologists have presumed to resort to a nascent order of things, or to revolutions in the economy of Nature, to explain every obscure phenomenon !

In some of the Shetland Isles, as on the west of Meikle Roe, dikes, or veins of soft granite have mouldered away ; while the matrix in which they were inclosed, being of the same substance, but of a firmer texture, has remained unaltered. Thus, long narrow ravines, sometimes twenty feet wide, are laid open, and often give access to the waves. After describing some huge cavernous apertures into which the sea flows for two hundred and fifty feet in Roeness, Dr. Hibbert enumerates other ravages of the ocean. “ A mass of rock, the average dimensions of which may perhaps be rated at twelve or thirteen feet square, and four and a half or five in thickness, was first moved from its bed, about fifty years ago, to a distance of thirty feet, and has since been twice turned over. But the most sublime scene is where a mural pile of porphyry, escaping the process of disintegration that is devastating the coast, appears to have been left as a sort of rampart against the inroads of the ocean ;—the Atlantic, when provoked by wintry gales, batters against it with all the force of real artillery—the

No. 8.



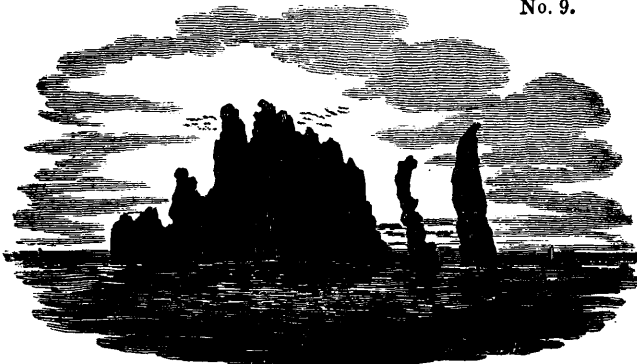
Grind of the Navir—Passage forced by the sea through rocks of hard porphyry.

waves having, in their repeated assaults, forced themselves an entrance. This breach, named the Grind of the Navir (No. 8), is widened every winter by the overwhelming surge that, finding a passage through it, separates large stones from its sides, and forces them to a distance of no less than one hundred and eighty feet. In two or three spots, the fragments which have been detached are brought together in immense heaps, that appear as an accumulation of cubical masses, the product of some quarry*.”

It is evident from this example, that although the greater indestructibility of some rocks may enable them to withstand, for a longer time, the action of the elements, yet they cannot permanently resist. There are localities in Shetland, in which rocks of almost every variety of mineral composition are suffering disintegration: thus the sea makes great inroads on the clay slate of Fitfel Head, on the serpentine of the Vord Hill in Fetlar, and on the mica-schist of the Bay of Triesta, on the east coast of the same isle, which decomposes in angular blocks. The quartz rock on the east of Walls, and the gneiss and mica-schist of Garthness, suffer the same fate.

Such devastation cannot be incessantly committed for thousands of years without dividing islands, until they become at last mere clusters of rocks, the last shreds of masses once continuous. To this state many appear to have been reduced, and innumerable fantastic forms are assumed by rocks adjoining these isles, to which the name of Drongs is applied, as it is to those of similar shape in Feroe.

No. 9.



Granitic rocks named the Drongs, between Papa Stour and Hillerwick Ness.

* Hibbert, p. 528.

The granitic rocks (No. 9) between Papa Stour and Hillswick Ness afford an example. A still more singular cluster of rocks is seen to the south of Hillswick Ness (No. 10), which presents a variety of forms as viewed from different points, and has often been likened to a small fleet of vessels with spread sails*.

No. 10.



Granitic Rocks to the south of Hillswick Ness, Shetland.

We may imagine that in the course of time Hillswick Ness itself may present a similar wreck, from the unequal decomposition of the rocks whereof it is composed, consisting of gneiss and mica schist, traversed in all directions by veins of felspar porphyry.

Midway between the groups of Shetland and Orkney is Fair Island, said to be composed of sandstone with high perpendicular cliffs. The current runs with such velocity, that during a calm, and when there is no swell, the rocks on its shores are white with the foam of the sea driven against them. The Orkneys, if carefully examined, would probably afford as much illustration of our present topic as the Shetland Islands. The north-east promontory of Sanda, one of these isles, has been cut off in modern times by the sea, so that it became what is now called Start Island, where a lighthouse was erected in 1807, since which time the new strait has grown broader.

East Coast of Scotland.—To pass over to the main land of Scotland, we find that, in Inverness-shire, there have been inroads of the sea at Fort George, and others in Murrayshire,

* Hibbert, p. 519.

which have swept away the old town of Findhorn. On the coast of Kincardineshire, an illustration was afforded, at the close of the last century, of the effect of promontories in protecting a line of low shore. The village of Mathers, two miles south of Johnshaven, was built on an ancient shingle beach, protected by a projecting ledge of limestone rock. This was quarried for lime to such an extent, that the sea broke through, and in 1795 carried away the whole village in one night, and penetrated one hundred and fifty yards inland, where it has maintained its ground ever since, the new village having been built farther inland on the new shore. In the Bay of Montrose, we find the North Esk and the South Esk rivers pouring annually into the sea large quantities of sand and pebbles, yet they have formed no deltas; for the tides scour out the channels, and the current, setting across their mouths, sweeps away all the materials. Considerable beds of shingle, brought down by the North Esk, are seen along the beach. Proceeding southwards, we find that at Arbroath, in Forfarshire, which stands on a rock of red sandstone, gardens and houses have been carried away within the last thirty years by encroachments of the sea. It has become necessary to remove the lighthouses at the mouth of the estuary of the Tay, in the same county, at Button Ness, which were built on a tract of blown sand, the sea having encroached for three-quarters of a mile.

A good illustration was afforded, during the building of the Bell Rock Lighthouse, at the mouth of the Frith of Tay, of the power which currents in estuaries can exert at considerable depths, in scouring out the channel. The Bell Rock is a sunken reef, consisting of red sandstone, being from twelve to sixteen feet under the surface at high water, and about twelve miles from the main land. At the distance of one hundred yards, there is a depth, in all directions, of two or three fathoms at low water. The perpendicular rise and fall of the spring-tides is fifteen feet, and at neap-tides, eight feet; their velocity varying from one to three miles per hour. In 1807, during the erection of the lighthouse, six large blocks of granite, which had been landed on the reef, were removed by the force of the sea, and thrown over a rising ledge to the distance of twelve or fifteen paces; and an anchor, weighing about

22 cwt., was thrown up upon the rock*. Mr. Stevenson informs us moreover, that drift-stones, measuring upwards of thirty cubic feet, or more than two tons weight, have, during storms, been often thrown upon the rock from the deep water †.

Among the proofs that the sea has encroached both in the estuaries of the Tay and Forth, may be mentioned the submarine forests which have been traced for several miles by Dr. Fleming, along the margins of those estuaries on the north and south shores of the county of Fife ‡. The alluvial tracts, however, on which such forests grow, generally occupy spaces which may be said to be in dispute between the river and the sea, and to be alternately lost and won. *Estuaries* (a term which we confine to inlets entered both by rivers and tides of the sea) have a tendency to become silted up *in parts*; but the same tracts, after remaining dry, perhaps, for thousands of years, are again liable to be overflowed, for they are always low, and, if inhabited, must generally be secured by artificial embankments. Meanwhile the sea devours, as it advances, the high as well as the low parts of the coast, breaking down, one after another, the rocky bulwarks which protect the mouths of estuaries. The changes of territory, therefore, within the general line of coast are all of a subordinate nature, in no way tending to arrest the march of the great ocean, nor to avert the destiny eventually awaiting the whole region; they are like the petty wars and conquests of the independent states and republics of Greece, while the power of Macedon was steadily pressing on, and preparing to swallow up the whole.

On the coast of Fife, at St. Andrew's, a tract of land which intervened between the castle of Cardinal Beaton and the sea has been entirely swept away, as were the last remains of the Priory of Crail, in the same county, in 1803. On both sides of the Frith of Forth, land has been consumed; at North Berwick in particular, and at Newhaven, where an arsenal and dock, built in the reign of James IV., in the fifteenth century has been overflowed.

* Account of the Erection of the Bell Rock Lighthouse, p. 163.

† Ed. Phil. Journ., vol. iii, p. 54, 1820.

‡ Quarterly Journal of Science, &c., No. XIII. new series, March, 1830.

East Coast of England.—If we now proceed to the English coast, we find records of numerous lands having been destroyed in Northumberland, as those near Banborough and Holy Island, and at Tynemouth Castle, which now overhangs the sea, although formerly separated from it by a strip of land. At Hartlepool, and several other parts of the coast of Durham composed of magnesian limestone, the sea has made considerable inroads. Almost the whole coast of Yorkshire, from the mouth of the Tees to that of the Humber, is in a state of gradual dilapidation. That part of the cliffs which consists of lias, the oolite series, and chalk, decays slowly. They present abrupt and naked precipices, often three hundred feet in height; and it is only at a few points that the grassy covering of the sloping talus marks a temporary relaxation of the erosive action of the sea. The chalk cliffs are washed into caves in the projecting headland of Flamborough, where they are decomposed by the salt vapours, and slowly crumble away. But the waste is most rapid between that promontory and Spurn Point, or the coast of Holderness, as it is called. This tract consists chiefly of beds of clay, gravel, sand, and chalk rubble. The irregular intermixture of the argillaceous beds causes many springs to be thrown out, and this facilitates the undermining process, the waves beating against them, and a strong current setting chiefly from the north. The wasteful action is very conspicuous at Dimlington Height, the loftiest point in Holderness, where the beacon stands on a cliff one hundred and forty-six feet above high water, the whole being composed of clay, with pebbles scattered through it*.

In the old maps of Yorkshire, we find spots, now sandbanks in the sea, marked as the ancient sites of the towns and villages of Auburn, Hartburn, and Hyde. “Of Hyde,” says Pennant, “only the tradition is left; and near the village of Hornsea, a street called Hornsea Beck has long since been swallowed †.” Owthorne and its church have also been in great part destroyed, and the village of Kilnsea; but these places are now removed farther inland. The rate of encroachment at Owthorne, at present, is about *four yards a year* ‡.

* Phillips's Geology of Yorkshire, p. 61.

† Arctic Zoology, vol. i., p. 10, Introduction.

‡ For this information I am indebted to Mr. Phillips, of York.

Not unreasonable fears are entertained that at some future time the Spurn Point will become an island, and that the ocean, entering into the estuary of the Humber, will cause great devastation *. Pennant, after speaking of the silting up of some ancient ports in that estuary, observes, " But, in return, the sea has made most ample reprisals; the site, and even the very names of several places, once towns of note upon the Humber, are now only recorded in history; and Ravensper was at one time a rival to Hull (Madox, *Ant. Exch. i.*, 422), and a port so very considerable in 1332, that Edward Balliol and the confederated English barons sailed from hence to invade Scotland; and Henry IV., in 1399, made choice of this port to land at, to effect the deposal of Richard II., yet the whole of it has long since been devoured by the merciless ocean: extensive sands, dry at low water, are to be seen in their stead †."

Pennant describes Spurn Head as a promontory in the form of a sickle, and says the land, for some miles to the north, was "perpetually preyed on by the fury of the German Sea, which devours whole acres at a time, and exposes on the shores considerable quantities of beautiful amber ‡."

According to Bergmann, a strip of land, with several villages, was carried away near the mouth of the Humber in 1475.

The maritime district of Lincolnshire consists chiefly of lands which lie below the level of the sea, being protected by embankments. Great parts of this fenny tract were, at some unknown period, a woody country, but were afterwards inundated, and are now again recovered from the sea. Some of the fens were embanked and drained by the Romans; but after their departure the sea returned, and large tracts were covered with beds of silt containing marine shells, now again converted into productive lands. Many dreadful catastrophes are recorded by incursions of the sea, whereby several parishes have been at different times overwhelmed.

We come next to the cliffs of Norfolk and Suffolk, where the decay is in general incessant and rapid. At Hunstanton, on the north, the undermining of the lower arenaceous beds at the foot of the cliff causes masses of red and white chalk to be precipitated from above. Between Hunstanton and Wey-

* Phillips's *Geology of Yorkshire*, p. 60.

† *Arct. Zool.*, vol. i., p. 10, Introduction.

‡ *Ibid.*

bourne, low hills, or dunes, of blown sand, are formed along the shore, from fifty to sixty feet high. They are composed of dry sand, bound in a compact mass by the long creeping roots of the plant called Marram (*Arundo arenaria*). Such is the present set of the tides, that the harbours of Clay, Wells, and other places, are securely defended by these barriers; affording a clear proof that it is not the strength of the material at particular points that determines whether the sea shall be progressive or stationary, but the general contour of the coast. The waves constantly undermine the low chalk cliffs, covered with sand and clay, between Weybourne and Sheringham, a certain portion of them being annually removed. At the latter town I ascertained, in 1829, some facts which throw light on the rate at which the sea gains upon the land. It was computed, when the present inn was built, in 1805, that it would require seventy years for the sea to reach the spot; the mean loss of land being calculated, from previous observations, to be somewhat less than one yard annually. The distance between the house and the sea was fifty yards; but no allowance was made for the slope of the ground being *from* the sea, in consequence of which, the waste was naturally accelerated every year, as the cliff grew lower, there being at each succeeding period less matter to remove when portions of equal area fell down. Between the years 1824 and 1829, no less than seventeen yards were swept away, and only a small garden was then left between the building and the sea. There is now a depth of twenty feet (sufficient to float a frigate) at one point in the harbour of that port, where, only forty-eight years ago, there stood a cliff fifty feet high, with houses upon it! If once in half a century an equal amount of change were produced at once by the momentary shock of an earthquake, history would be filled with records of such wonderful revolutions of the earth's surface, but, if the conversion of high land into deep sea be gradual, it excites only local attention. The flag-staff of the Preventive Service station, on the south side of this harbour, has, within the last fifteen years, been thrice removed inland, in consequence of the advance of the sea.

Farther to the south we find cliffs, composed, like those of Holderness before mentioned, of alternating strata of blue clay, gravel, loam, and fine sand. Although they sometimes exceed

two hundred feet in height, the havoc made on the coast is most formidable. The whole site of ancient Cromer now forms part of the German Ocean, the inhabitants having gradually retreated inland to their present situation, from whence the sea still threatens to dislodge them. In the winter of 1825, a fallen mass was precipitated from near the lighthouse, which covered twelve acres, extending far into the sea, the cliffs being two hundred and fifty feet in height*. The undermining by springs has sometimes caused large portions of the upper part of the cliffs, with houses still standing upon them, to give way, so that it is impossible, by erecting breakwaters at the base of the cliffs, permanently to ward off the danger. On the same coast, the ancient villages of Shipden, Wimpwell, and Eccles, have disappeared; several manors and large portions of neighbouring parishes having, piece after piece, been swallowed up; nor has there been any intermission, from time immemorial, in the ravages of the sea along a line of coast twenty miles in length, in which these places stood †. Hills of blown sand, between Eccles and Winterton, have barred up and excluded the tide for many hundred years from the mouths of several small estuaries; but there are records of nine breaches, from twenty to one hundred and twenty yards wide, having been made through these, whereby immense damage was done to the low grounds in the interior. A few miles south of Happisburgh, also, are hills of blown sand, which extend to Yarmouth; and these are supposed to protect the coast, but in fact their formation proves that a temporary respite of the incursions of the sea on this part is permitted by the present set of the tides and currents. Were it otherwise, the land, as we have seen, would give way, though made of solid rock.

At Yarmouth, the sea has not advanced upon the sands in the slightest degree since the reign of Elizabeth. In the time of the Saxons, a great estuary extended as far as Norwich, which city is represented, even in the thirteenth and fourteenth centuries, as "situated on the banks of an arm of the sea." The sands whereon Yarmouth is built first became firm and habitable ground about the year 1008, from which time a line of dunes has gradually increased in height and breadth, stretching

* Taylor's Geology of East Norfolk, p. 32.

† Ibid.

across the whole entrance of the ancient estuary, and obstructing the ingress of the tides so completely, that they are only admitted by the narrow passage which the river keeps open, and which has gradually shifted several miles to the south. The tides at the river's mouth only rise, at present, to the height of three or four feet. By the exclusion of the sea, thousands of acres in the interior have become cultivated lands; and, exclusive of smaller pools, upwards of sixty fresh water lakes have been formed, varying in depth from fifteen to thirty feet, and in extent from one acre to twelve hundred*. The Yare, and other rivers, frequently communicate with these sheets of water; and thus they are liable to be filled up gradually with lacustrine and fluviatile deposits, and to be converted into land covered with forests. When the sea at length returns (for as the whole coast gives way, this must inevitably happen sooner or later), these tracts will be again submerged, and submarine forests may then be found, as along the margins of many estuaries. We may easily conceive that such natural embankments as those thrown by the waves, and subsequently raised by winds, across the entrance of this river, may so shut out the tide, that inland places may become dry which, on the breaching of the barrier, might again be permanently overflowed even at low water; for the tides are now so depressed, even outside the barrier, that the river is almost in the condition of one which enters an inland sea. Were high tides to recur, the fresh-water would be ponded back during the flow, and would perhaps not entirely escape during the ebb. It has been observed, by Dr. Fleming, that the roots of the trees in several submarine forests in Scotland are in lacustrine silt. The stumps of the trees evidently occupy the position in which they formerly grew, and are sometimes from eight to ten feet below high water mark. The horizontality of the strata and other circumstances, preclude the supposition of a slide, and the countries in question have been from time immemorial free from violent earthquakes, which might have produced subsidences. He has, therefore, attributed the depression, with much probability, to the drainage of peaty soil on the removal of a seaward barrier. Suppose a lake (like one of those in the

* Taylor's Geology of East Norfolk, p. 10.

valley of the Yare,) to become a marsh, and a stratum of vegetable matter to be formed on the surface, of sufficient density to support trees. Let the outlet of the marsh be elevated a few feet only above the rise of the tide. All the strata below the level of the outlet would be kept constantly wet or in a semifluid state, but if the tides rise in the estuary, and the sea encroaches, portions of the gained lands are swept away, and the extremities of the alluvial and peaty strata, whereon the forest grew, are exposed to the sea, and at every ebb tide left dry to a depth equal to the increased fall of the tide. Much water, formerly prevented from escaping by the altitude of the outlet, now oozes out from the moist beds,—the strata collapse and the surface of the morass instead of remaining at its original height, sinks below the level of the sea*.

Yarmouth does not project beyond the general line of coast which has been rounded off by the predominating current from the north-west. It must not be imagined, therefore, that the acquisition of new land fit for cultivation in Norfolk and Suffolk indicates any permanent growth of the eastern limits of our island, to compensate its reiterated losses. No *delta* can form on such a shore.

The cliffs of Suffolk, to which we next proceed, are somewhat less elevated than those of Norfolk, but composed of similar accumulations of alternating clay, sand, and gravel. From Gorleston in Suffolk, to within a few miles north of Lowestoff, the cliffs are slowly undermined. Near the last-mentioned town, there is an inland cliff about sixty feet high, the talus being covered with turf and heath, between which and the sea is a low, flat tract of sand, called the Ness, which gains slowly on the sea. It does not seem difficult to account for the retreat of the sea at this point from its ancient limits, the base of the inland cliff. About a mile off Lowestoff lies the Holm Sand, the highest part of which is dry at low water. The current in the intervening passage, called Lowestoff Roads, is a back-water, wherein the tide, instead of obeying the general rule along this coast, runs nine hours towards the north, and only three towards the south. Here, therefore, we have an

* See two papers on Submarine Forests by the Rev. Dr. Fleming, in the *Trans. Roy. Soc. Edin.*, vol. ix., p. 419, and *Quarterly Journ. of Sci.*, No. 13, new series, March, 1830.

eddy, and the Holm Sand is a bank caused by the meeting of currents, where, as usual, sediment subsides. The channel called Lowestoff Roads is about a mile broad, and the depth varies from twenty to fifty-nine feet at low water. On one side, the current has hollowed out of the Holm Sand a deep curve, called the Hook, and on the other side precisely opposite, is the projecting point of the Ness*. As the *points* and *bends* of a river correspond to each other, sand-bars being thrown up at each point, and the greatest depth being where the river is wearing into the bend, so we find here a shoal increasing at the Ness, and deep water preserved in the Hook. We cannot doubt that, at a modern period in the history of this coast, the high cliffs on which Lowestoff stands, were once continuous across the space where the roadstead now is, and where we have stated the present depth to be fifty-nine feet at low water.

By the mean of thirty-eight observations, it has been found that the difference of high and low tide at Lowestoff is only five feet eight inches †—a remarkably slight oscillation for our eastern coast, and which naturally suggests the inquiry whether, at other points where there are inland cliffs, the rise of the tides is below their average level.

The sea undermines the high cliffs a few miles north of Lowestoff, near Corton; as also two miles south of the same town, at Pakefield, a village which has been in part swept away during the present century. From thence to Dunwich the destruction is constant. At the distance of two hundred and fifty yards from the wasting cliff at Pakefield, the sea is sixteen feet deep at low water, and in the roadstead beyond, twenty-four feet. Of the gradual destruction of Dunwich, once the most considerable sea-port on this coast, we have many authentic records. Gardner, in his *History of that borough*, published in 1754, shows, by reference to documents beginning with *Doomsday Book*, that the cliffs at Dunwich, Southwold, Eastern, and Pakefield, have been always subject to wear away. At Dunwich, in particular, two tracts of land which had been taxed in the eleventh century, in the time of King

* See *Plan of proposed Canal at Lowestoff*, by Cubitt and Taylor, 1826.

† These observations were made by Mr. R. C. Taylor.

Edward the Confessor, are mentioned, in the Conqueror's survey, made but a few years afterwards, as having been devoured by the sea. The losses, at a subsequent period, of a monastery—at another of several churches—afterwards of the old port—then of four hundred houses at once—of the church of St. Leonard, the high road, town-hall, gaol, and many other buildings, are mentioned, with the dates when they perished. It is stated that, in the sixteenth century, not one quarter of the town was left standing; yet the inhabitants retreating inland, the name was preserved, as has been the case with many other ports when their ancient site has been blotted out. There is, however, a church, of considerable antiquity, still standing, the last of twelve mentioned in some records. In 1740, the laying open of the churchyard of St. Nicholas and St. Francis, in the sea cliffs, is well described by Gardner, with the coffins and skeletons exposed to view,—some lying on the beach, and rocked

In cradle of the rude imperious surge.

Of these cemeteries, no remains can now be seen. Ray also says, “that ancient writings make mention of a wood a mile and a half to the east of Dunwich, the site of which must at present be so far within the sea*.” This city, once so flourishing and populous, is now a small village, with about twenty houses and one hundred inhabitants.

There is an old tradition, “that the tailors sat in their shops at Dunwich, and saw the ships in Yarmouth Bay;” but when we consider how far the coast at Lowestoff Ness projects between these places, we cannot give credit to the tale, which, nevertheless, proves how much the inroads of the sea in times of old prompted men of lively imagination to indulge a taste for the marvellous.

Gardner's description of the cemeteries laid open by the waves reminds us of the scene which has been so well depicted by Bewick †, and of which numerous points on our coast might have suggested the idea. On the verge of a cliff, which the sea has undermined, are represented the unshaken tower and western end of an abbey. The eastern aisle is gone,

* Consequences of the Deluge, Phys. Theol. Discourses.

† History of British Birds, vol. ii., p. 220, Ed. 1821.

and the pillars of the cloister are soon to follow. The waves have almost isolated the promontory, and invaded the cemetery, where they have made sport with the mortal relics, and thrown up a skull upon the beach. In the foreground is seen a broken tombstone, erected, as its legend tells, "to *perpetuate the memory*" of one whose name is obliterated, as is that of the county for which he was "Custos Rotulorum." A cormorant is perched on the monument, defiling it, as if to remind some moralizer like Hamlet of "the base uses" to which things sacred may be turned. Had this excellent artist desired to satirize certain popular theories of geology, he might have inscribed the stone to the memory of some philosopher who taught "the permanency of existing continents"—"the era of repose"—"the impotence of modern causes."

South of Dunwich are two cliffs, called Great and Little Cat Cliff. That which bears the name of Great, has become the smallest of the two, and is only fifteen feet high, the more elevated portion of the hill having been carried away; on the other hand, the Lesser Cat Cliff has gained in importance, for the sea has here been cutting deeper into a hill which slopes towards it. But at no distant period, the ancient names will again become appropriate, for at Great Cat Cliff, the base of another hill will soon be reached, and at Little Cat Cliff, the sea will, at about the same time, arrive at a valley.

The incursions of the sea at Aldborough were formerly very destructive, and this borough is known to have been once situated a quarter of a mile east of the present shore. The inhabitants continued to build farther inland, till they arrived at the extremity of their property, and then the town decayed greatly, but two sand-banks, thrown up at a short distance, now afford a temporary safeguard to the coast. Between these banks and the present shore, where the current now flows, the sea is twenty-four feet deep on the spot where the town formerly stood. Continuing our survey of the Suffolk coast to the southward, we find that the cliffs of Bawdsey and Felixtow are foundering slowly, and that the point on which Landguard Fort is built suffers gradual decay. It appears that, within the memory of persons now living, the Orwell river continued its course in a more direct line to the sea, and entered to the

north instead of the south of the low bank on which the fort last mentioned is built.

Harwich, in Essex, stands on an isthmus, which will probably become an island in little more than half a century; for the sea will then have made a breach near Lower Dover Court, should it continue to advance as rapidly as it has done during the last fifty years. Within ten years, there was a considerable space between the battery at Harwich, built twenty-three years ago, and the sea; part of the fortification has already been swept away, and the rest overhangs the water.

At Walton Naze, in the same county, the cliffs, composed of London clay, capped by the shelly sands of the crag, reach the height of about one hundred feet, and are annually undermined by the waves. The old churchyard of Walton has been washed away, and the cliffs to the south are continually disappearing.

On the coast bounding the estuary of the Thames, there are numerous examples both of the gain and loss of land. The Isle of Sheppey, which is now about six miles long by four in breadth, is composed of London clay. The cliffs on the north, which are from sixty to eighty feet high, decay rapidly, fifty acres having been lost within the last twenty years. The church at Minster, now near the coast, is said to have been in the middle of the island fifty years ago; and it is computed that, at the present rate of destruction, the whole isle will be annihilated in about another half century*. On the coast to the east of Sheppey stands the Church of Reculver, upon a sandy cliff about twenty feet high. In the reign of Henry VIII. it is said to have been nearly a mile distant from the sea. In the "Gentleman's Magazine," there is a view of it about the middle of the last century, which still represents a considerable space as intervening between the north wall of the churchyard and the cliff. About twenty years ago, the waves came within one hundred and fifty feet of the boundary of the churchyard, half of which has since been washed away. The church is now dismantled (1829), and is in great danger; several houses in a field immediately adjoining having been washed away.

* For this information I am indebted to W. Gunnell, Esq.

In the Isle of Thanet, Bedlam Farm, belonging to the hospital of that name, has lost eight acres in the last twenty years, the land being chalk from forty to fifty feet above the level of the sea. It has been computed, that the average waste of the cliff between the North Foreland and the Reculvers, a distance of about eleven miles, is not less than two feet per annum. The chalk cliffs on the south of Thanet, between Ramsgate and Pegwell Bay, have, on an average, lost three feet per annum for the ten last years. The Goodwin Sands lie opposite this part of the Kentish coast. They are about ten miles in length, and are in some parts three, and in others, seven miles distant from the shore, and, for a certain space, are laid bare at low water. When the erection of a lighthouse on these sands was in contemplation by the Trinity Board, twelve years since, it was found, by borings, that the bank consisted of fifteen feet of sand, resting on blue clay. An obscure tradition has come down to us, that the estates of Earl Goodwin were situated here, and some have conjectured that they were overwhelmed by the flood mentioned in the Saxon Chronicle, *sub anno* 1099. The last remains of an island, consisting, like Sheppey, of clay, may, perhaps, have been carried away about that time.

In the county of Kent, there are other records of waste, at Deal; and at Dover, Shakspeare's Cliff, composed entirely of chalk, has suffered greatly, and continually diminishes in height, the slope of the hill being towards the land. About twenty years ago, there was an immense land-slip from this cliff, by which Dover was shaken as if by an earthquake. In proceeding from the northern parts of the German Ocean towards the Straits of Dover, the water becomes gradually more shallow, so that in the distance of about two hundred leagues, we pass from a depth of one hundred and twenty, to that of fifty-eight, thirty-eight, twenty-four, and eighteen fathoms. In the same manner, the English Channel deepens progressively from Dover to its entrance, formed by the Land's End of England, and the Isle of Ushant on the coast of France; so that the strait between Dover and Calais may be said to form a point of partition between two great inclined planes, forming the bottom of these seas*.

* Stevenson on the Bed of the German Ocean,—Ed. Phil. Journ., No. V., p. 45.

Whether England was formerly united with France has often been a favourite subject of speculation; and in 1753 a society at Amiens proposed this as the subject of a prize essay, which was gained by the celebrated Desmarest, then a young man. He founded his principal arguments on the identity of composition of the cliffs on the opposite sides of the Channel, on a submarine chain extending from Boulogne to Folkestone, only fourteen feet under low water, and on the identity of the noxious animals in England and France, which could not have swam across the straits, and would never have been introduced by man. He also attributed the rupture of the isthmus to the preponderating violence of the current from the north*. It will hardly be disputed that the ocean might have effected a breach through the land which, in all probability, once united our country to the continent, in the same manner as it now gradually forces a passage through rocks of the same mineral composition, and often many hundred feet high, upon our coast. Although the time required for such an operation was probably very great, yet we cannot estimate it by reference to the present rate of waste on both sides of the Channel. For when, in the thirteenth century, the sea burst through the isthmus of Staveren, which formerly united Friesland with North Holland, it opened in about one hundred years a strait more than half as wide as that which divides England from France, after which the dimensions of the new channel remained almost stationary. The greatest depth of the straits between Dover and Calais is twenty-nine fathoms, which only exceeds, by one fathom, the greatest depth of the Mississippi at New Orleans. If the moving column of water in the great American river, which, as we before stated, does not flow rapidly, can maintain an open passage to that depth in its alluvial accumulations, still more might a channel of the same magnitude be excavated by the resistless force of the tides and currents of "the ocean stream,"

ποταμιοι μεγα σθενος Ωκεανου.

At Folkestone, the sea eats away the chalk and subjacent strata. About the year 1716, there was a remarkable sinking

* Cuvier, *Éloge de Desmarest.*

of a tract of land near the sea, so that houses became visible at points near the shore, from whence they could not be seen previously. In the description of this subsidence in the *Philosophical Transactions*, it is said, "that the land consisted of a solid stony mass (chalk), resting on wet clay (galt), so that it slid forwards towards the sea, just as a ship is launched on tallowed planks." It is also stated that, within the memory of persons then living, the cliff there had been washed away to the extent of ten rods*. Encroachments of the sea at Hythe are also on record; but between this point and Rye there has been a gain of land, within the times of history; the rich level tract called Romney Marsh, about ten miles in width and five in breadth, consisting of silt, having received great accession. It has been necessary, however, to protect it, from the earliest periods, by a wall from the sea. These additions of land are exactly opposite that part of the English Channel where the conflicting tides meet; for as those from the north are the most powerful, they do not neutralize each other's force till they arrive at this distance from the straits. Rye, on the south of this tract, was once destroyed by the sea, but it is now two miles distant from it. The neighbouring town of Winchelsea was destroyed in the reign of Edward I., the mouth of the Rother stopped up, and the river diverted into another channel. In its old bed an ancient vessel, apparently a Dutch merchantman, was recently found. It was built entirely of oak, and much blackened †.

South Coast of England.—To pass over some points near Hastings, where the cliffs have wasted at several periods, we arrive at the promontory of Beachy Head. Here a mass of chalk, three hundred feet in length, and from seventy to eighty in breadth, fell, in the year 1813, with a tremendous crash; and similar slips have since been frequent ‡.

About a mile to the west of the town of Newhaven the remains of an ancient entrenchment are seen, on the brow of Castle Hill. This earth-work was evidently once of considerable extent, but the greater part has been cut away. The cliffs, which are undermined here, are high; more than one hundred feet of chalk being covered by tertiary clay and sand,

* *Phil. Trans.*, 1716. † *Edin. Journ. of Sci.*, No. xix., p. 56.

‡ *Webster, Geol. Trans.*, vol. iii., p. 192.

from sixty to seventy feet in thickness. In a few centuries the last vestiges of the plastic clay formation on the southern borders of the chalk of the South Downs on this coast will be annihilated, and future geologists will learn, from historical documents, the ancient geographical boundaries of groups of strata then no more. On the opposite side of the estuary of the Ouse, on the east of Newhaven harbour, a bed of shingle, composed of chalk flints, derived from the waste of the adjoining cliffs, had accumulated at Seaford for several centuries. In the great storm of November, 1824, this bank was entirely swept away, and the town of Seaford inundated. Another great beach of shingle is now forming from fresh materials.

The whole coast of Sussex has been incessantly encroached upon by the sea from time immemorial; and, although sudden inundations only, which overwhelmed fertile or inhabited tracts are noticed in history, the records attest an extraordinary amount of loss. During a period of no more than eighty years, there are notices of about *twenty* inroads in which tracts of land of from twenty to *four hundred acres* in extent were overwhelmed at once; the value of the tithes being mentioned by Nicholas, in his *Taxatio Ecclesiastica* *. In the reign of Elizabeth, the town of Brighton was situated on that tract where the chain-pier now extends into the sea. In the year 1665, twenty-two tenements had been destroyed under the cliff. At that period there still remained under the cliff one hundred and thirteen tenements, the whole of which were overwhelmed in 1703 and 1705. No traces of the ancient town are now perceptible, yet there is evidence that the sea has merely resumed its ancient position at the base of the cliffs, the site of the old town having been merely a beach abandoned by the ocean for ages. It would be endless to allude to all the localities on the Sussex and Hampshire coasts, where the land has been destroyed; but we may point to the relation of the present shape and geological structure of the Isle of Wight, as attesting that it owes its present outline to the continued action of the sea. Through the middle of the island a high ridge of chalk strata, in a vertical position, runs in a direction east and west. This chalk forms the projecting promontory of Culver Cliff on the east,

* Mantell, *Geology of Sussex*, p. 293.

and of the Needles on the west ; while Sandown Bay on the one side, and Compton Bay on the other, have been hollowed out of the softer sands and argillaceous strata, which are inferior to the chalk. The same phenomena are repeated in the Isle of Purbeck, where the line of vertical chalk forms the projecting promontory of Handfast Point ; and Swanage Bay marks the deep excavation made by the waves in the softer strata, corresponding to those of Sandown Bay.

The entrance of the Channel called the Solent is becoming broader by the waste of the cliffs in Colwell Bay ; it is crossed for more than two-thirds of its width by the shingle bank of Hurst Castle, which is about seventy yards broad, and twelve feet high, presenting an inclined plane to the west. This singular bar consists of a bed of rounded chalk flints, resting on an argillaceous base, always covered by the sea. The flints and a few other pebbles, intermixed, are exclusively derived from the waste of Hordwell, and other cliffs to the westward, where fresh-water marls, capped with a covering of chalk flints from five to fifty feet thick, are rapidly undermined.

In the great storm of November, 1824, this bank of shingle was moved bodily forwards for forty yards towards the north-east ; and certain piles which served to mark the boundaries of two manors were found, after the storm, on the opposite side of the bar. At the same time many acres of pasture land were covered by shingle, on the farm of Westover, near Lymington. This bar probably marks the line where the opposing tides meet, for there is a second, or half-tide, of eighteen inches, three hours after the regular tide in this channel.

The cliffs between Hurst Shingle Bar and the mouth of the Stour and Avon are undermined continually. Within the memory of persons now living, it has been necessary thrice to remove the coast-road farther inland. The tradition, therefore, is probably true, that the church of Hordwell was once in the middle of that parish, although now very near the sea. The promontory of Christ Church Head gives way slowly. It is the only point between Lymington and Poole Harbour where any hard stony masses occur in the cliffs. Five layers of large ferruginous concretions, somewhat like the septaria of the London clay, have occasioned a resistance at this point, to which we may ascribe the existence of this headland. In the

mean time, the waves have cut deeply into the soft sands and loam of Poole Bay ; and, after severe frosts, great land-slips take place, which by degrees become enlarged into narrow ravines, or chines, as they are called, with vertical sides. One of these chines, near Boscomb, has been deepened twenty feet within a few years. At the head of each there is a spring, the waters of which have been chiefly instrumental in producing these narrow excavations, which are sometimes from one hundred to one hundred and fifty feet deep.

The peninsulas of Purbeck and Portland are continually wasting away. In the latter, the soft argillaceous substratum (Kimmeridge clay) hastens the dilapidation of the superincumbent mass of limestone.

In 1665, the cliffs adjoining the principal quarries gave way to the extent of one hundred yards, and fell into the sea ; and in December, 1734, a slide to the extent of one hundred and fifty yards occurred on the east side of the isle, by which several skeletons, buried between slabs of stone, were discovered. But a much more memorable occurrence of this nature, in 1792, is thus described in Hutchins's History of Dorsetshire. " Early in the morning the road was observed to crack : this continued increasing, and before two o'clock the ground had sunk several feet, and was in one continued motion, but attended with no other noise than what was occasioned by the separation of the roots and brambles, and now and then a falling rock. At night it seemed to stop a little, but soon moved again ; and before morning, the ground, from the top of the cliff to the water-side, had sunk in some places fifty feet perpendicular. The extent of ground that moved was about *a mile and a quarter* from north to south, and six hundred yards from east to west."

Portland is connected with the main land by the Chesil Bank, a ridge of shingle about seventeen miles in length, and, in most places, nearly a quarter of a mile in breadth. The pebbles forming this immense barrier are chiefly of limestone ; but there are many of quartz, jasper, chert, and other substances, all loosely thrown together. What is singular, they gradually diminish in size, from the Portland end of the bank to that which attaches to the main land. The formation of this bar may probably be ascribed, like that of Hurst Castle, to a meet-

ing of tides, or to a great eddy, between the peninsula and the land. We have seen that slight obstructions in the course of the Ganges will cause, in the course of a man's life, islands many times larger than the whole of Portland, and which, in some cases, consist of a column of earth more than one hundred feet deep. In like manner, we may expect the slightest impediment in the course of that tidal wave, which is sweeping away annually large tracts of our coast, to give rise to banks of sand and shingle many miles in length, if the transported materials be intercepted in their passage to those submarine receptacles whither they are borne by the current. The gradual diminution in the size of the gravel, as we proceed eastward, might probably admit of explanation, if the velocity of the tide or eddy at different points was ascertained; the rolled masses thrown up being largest where the motion of the water is most violent, or where they are deposited at the least distance from the rocks from which they were detached. The storm of 1824 burst over this bar with great fury, and the village of Chesilton, built upon the southern extremity of the bank, was overwhelmed, with many of the inhabitants*. The fundamental rocks whereon the shingle rests are found at the depth of a few yards only below the level of the sea.

At Lyme Regis, in Dorsetshire, the "Church Cliffs," as they are called, consisting of lias, about one hundred feet in height, have gradually fallen away, at the rate of one yard a year, since 1800†. The cliffs of Devonshire and Cornwall, which are chiefly composed of hard rocks, decay less rapidly. Near Penzance, in Cornwall, there is a projecting tongue of land, called the "Green," formed of granitic sand,

* This same storm carried away part of the Breakwater at Plymouth, and huge masses of rock were lifted from the bottom of the weather side, and rolled fairly to the top of the pile. It was in the same month, and also during a spring tide, that a great flood is mentioned on the coasts of England, in the year 1099. Florence of Worcester says, "On the third day of the nones of Nov., 1099, the sea came out upon the shore, and buried towns and men very many, and oxen and sheep innumerable." Also the Saxon Chronicle, already cited, for the year 1099, "This year eke on St. Martin's-mass day, the 11th of Novembre, sprung up so much of the sea flood, and so myckle harm did, as no man minded that it ever afore did, and there was the ylk day a new moon."

† This ground was measured by Dr. Carpenter, of Lyme, in 1800, and again in 1829.

from which more than thirty acres of pasture land have been gradually swept away in the course of the last two or three centuries*. It is also said that St. Michael's Mount, now an insular rock, was formerly situated in a wood several miles from the sea; and its old Cornish name, according to Carew, signifies the Hoare Rock in the Wood. Between the Mount and Newlyn, there is seen, under the sand, black vegetable mould, full of hazel nuts, and the branches, leaves, roots, and trunks of forest trees, all of indigenous species. This vegetable stratum has been traced seaward as far as the ebb permits, and seems to indicate some ancient estuary on that shore.

The oldest historians mention a celebrated tradition in Cornwall of the submersion of the Lionnesse, a country which formerly stretched from the Land's End to the Scilly Islands. The tract, if it existed, must have been thirty miles in length, and perhaps ten in breadth. The land now remaining on either side is from two hundred to three hundred feet high; the intervening sea about three hundred feet deep. Although there is no evidence for this romantic tale, it probably originated in some catastrophe occasioned by former inroads of the Atlantic upon this exposed coast †.

Having now laid before the reader an ample body of proofs of the destructive operations of tides and currents on our eastern and southern shores, it will be unnecessary to enter into details of changes on the western coast, for they present merely a repetition of the same phenomena, and in general on an inferior scale. On the borders of the estuary of the Severn, the flats of Somersetshire and Gloucestershire have received enormous accessions, while, on the other hand, submarine forests on the coast of Lancashire indicate the overflowing of alluvial tracts. There are traditions in Pembrokeshire ‡ and Cardiganshire § of far greater losses of territory than that which the Lionnesse tale of Cornwall pretends to commemorate. They are all important, as demonstrating that the earliest inhabitants were familiar with the phenomenon of incursions of the sea.

The French coast, particularly that of Brittany, where the

* Boase, *Trans. Royal Geol. Soc. of Cornwall*, vol. ii., p. 129. † *Ibid.*, p. 130.

‡ Camden, who cites Gyraldus, also Ray, "On the Deluge." *Phys. Theol.* p. 228.

§ Meyrick's Cardigan.

tides rise to an extraordinary height, is the constant prey of the waves. In the ninth century many villages and woods are reported to have been carried away, the coast undergoing great change, whereby the hill of St. Michael was detached from the main land. The parish of Bourgneuf, and several others in that neighbourhood, were overflowed in the year 1500. In 1735, during a great storm, the ruins of Palnel were seen uncovered in the sea *. A romantic tradition, moreover, has descended from the fabulous ages, of the destruction of the south-western part of Brittany, whence we may probably infer some great inroad of the sea at a remote period †.

* Hoff, Geschichte, &c., vol. i., p. 49.

† Ibid., p. 48.
