January 26, 1864.

JOHN ROBINSON McCLEAN, President,
in the Chair.

No. 1,103.—“The East Coast between the Thames and the Wash Estuaries.” By JOHN BALDRY REDMAN, M. Inst. C.E.

THE Author hopes that the following description of the Coast, between the Thames and the Wash, being similar in character to that given in 1852,² of the South Coast between the Thames and Portland, will be of interest to the Members; and that, in the course of the discussion, such further, and supplementary information will be elicited as will place on the records of the Institution a complete history of the changes which have taken place on that part of the English Coast, and an exact analysis of the causes from which they have arisen. On the South Coast the leeward progression of the shingle is up Channel, due to the preponderance of S.W. winds; along the eastern seaboard the motion is southward, owing to the greater influence of northerly winds, except along the north coast of Norfolk, towards the Estuary of the Wash, where the motion is in a westerly direction.

The greater development of tidal scour in the upper reaches of the river Thames, arising from an increased rise at high water, and a considerable fall at low water, both being due to the removal of old London Bridge, assisted by the progressive removal of shoals, is well known.

As a proof that dredging is required to a greater extent, it is only necessary to state the facts, that the depth at low water from London Bridge to Woolwich is generally 10 feet, thence to Dagenham it is from 15 feet to 20 feet, below to Purfleet it is from 20 feet to 30 feet, and thence to Gravesend it is from 30 feet to 40 feet, whilst below Barking Creek, Dagenham Shoal has only from 8 feet to 9 feet of water upon it.

Almost the entire area of Halfway Reach is encumbered with ‘debris,’ caused by breaches, that formerly occurred in the river walls; for with a mid low-water channel of 20 feet, both above and

¹ The discussion upon this Paper occupied portions of four evenings, but an abstract of the whole is given consecutively.

² *Vide* Minutes of Proceedings, Inst. C.E., vol. xi., pp. 162–204.

below, there is over the area of this reach only from 10 feet to 12 feet—in fact there is a submerged ‘plateau’ across the river. The same remark applies to Erith Reach, where with a depth of 30 feet above and below, there are shoals with only from 6 feet to 10 feet of water.

Though the general features of the Thames Estuary are familiar, many silent and scarce-recorded changes constantly occur along its shores. The sandbanks of its delta, from their nature, are subject to frequent change, and require constant supervision. The modern buoyage of the Prince’s Channel, which has 6 feet more water than the Queen’s Channel to the south of it, and which was formerly used by outward-bound vessels; the formation of a deep channel between the Girdler and Shingle Sand in 1861, and the subsequent shifting of the Girdler Light-vessel are cases in point.

The foreshores below Gravesend increase in width. The Blyth Sand, forming the southern boundary of the outfall of the river, called Sea Reach, is nearly 10 miles in length, by 1 mile in breadth at low water; and the Maplin and Foulness Sands below, on the north side, stretch out in one continuous belt of from 18 miles to 20 miles in length below Southend, with a breadth of from 2 miles to 4 miles at low water.

The low cliffs of London clay crowned with tertiary crag, between Leigh and Southend, are subject to falls, similar to those in the Isle of Sheppey of the same formation on the opposite shore.

At St. Osyth’s, commences the great degradation of the coast to be presently noticed, the whole seaboard from the Colne to Harwich having experienced great change. St. Osyth’s Priory forms a well-known sea-mark. Martello Tower No. 1 is within the marsh wall below the outfall of Brightlingsea Creek; No. 2 is situate on a low tertiary cliff; the small triangular fort or curtain in front is split up and has partially fallen, in consequence of the subsidence of the undercliff. St. Osyth, Wick, and Clacton marshes are defended by earthen sea walls; the sandy foreshore east of St. Osyth’s Point has a small shingle ‘full’ at the top, backed by sandhills, and the shingle here commences to have two regularly-defined spring and neap ‘fulls.’ At Martello Tower No. 3, it runs out into a small point; and west of this tower a groyne, deeply buried in shingle, denotes a local increase; and eastward of the battery, there is a corresponding accumulation of beach increasing in breadth.

West of Lion Point or Eastness, a groyne on the sand foreshore, below the beach, denotes the retreat landward of the latter. The planked groynes and parallel breastwork, in front of Tower No. 4 and its battery, are further indicative of the waste of the shore; and Tower No. 5 is protected by similar defences.

Tower No. 6 is situate on the commencement of Clacton Cliff,

which is about 40 feet high, composed of loamy clay full of chimes and slips, and it appears to have been wasted, to the extent of the breadth of the beach now lying at its base, during the last five years. The shingle decreases in quantity, and is occasionally entirely swept away, leaving only fine sand to resist the impact of the sea, groynes having failed to arrest the decay. At Holland Gap a timber parallel breastwork is also constructed. Clacton Cliff may be termed an intermixture of fallow and foreshore; for the yellow tertiary cliff, being subject to constant change, slides forward, leaving the former and meeting the latter.

At Holland the mere basements of the east buttresses of the church are left, indicating the site of the ruins. Here, on a mile of frontage, three acres of land have been lost in eight years, equal to a recession of 1 yard per annum; and the Scott (tax) on the 697 acres of Tendring Level, has risen from the average of 15s. 6d. per acre to 18s. 6d. per acre, and even to 25s. per acre.

Holland Haven has its outfall between Clacton and Frinton Cliffs. Here, a large crescent mole of shingle is driven by the volume of land water as far out as ordinary low-water mark, with a mean direction N.E. by N. and S.W. by S., and an average height of 10 feet above the shore. Holland Marsh wall is piled and faggoted, and groynes project at right angles across the foreshore.

The groynes, at the foot of Frinton Cliff, have not arrested the decay. Acres of undercliff lie below, as broad as the foreshore beyond, resembling a great railway 'tip' constantly progressing, with this difference, that the undercliff has a decreasing instead of an increasing bank; the falls take place in deep, rounded, indented scoops, leaving jutting points between.

Beyond Frinton Chapel Ruins, a portion of which is enclosed, at Burnt House Farm, a modern fall is close up to the house, the coast path is diverted down the slope of the undercliff; and a timber breastwork has been placed below, with groynes to check the progressive decay.

The Clacton, Holland, and Frinton Cliffs to the south of the town of Walton-le-Soken and the Walton cliffs northwards, have fallen coincident with all record; and sea walls and other defences have been erected during the last thirty years, to keep the sea in check, in front of the town; but immediately north, the low cliff is much eaten into, the sea wall standing out as a jutting point.

The Naze, towards the sea-mark, becomes one continuous avalanche of London clay and yellow sand; masses are deposited on the mud foreshore, with the grass of the season on them. 'Platymore' forms the wide flat foreshore, which has no shingle and numerous groynes. One large slip is split up into laminæ, pre-

senting similar appearances to those at Warden Point, in the Isle of Sheppy.¹

Another large slip may be particularized, where attempts have been made, by staking the top and draining the slope, to render it more permanent. Opposite the sea-mark the slips become extensive, in huge masses from 50 yards to 100 yards in breadth, and attempts are being made to drain the undercliff thus formed. A large portion of the crown of the Naze is formed of yellow 'crag.'

Fig. 1.

ISLE OF SHEPPY, WARDEN POINT. — LANDSLIP.
View from W., looking towards the Reculvers.

Fig. 2.

Sectional Sketch.

¹ The fall at Warden Point is now much modified in appearance.—J. B. R.
29th June, 1865.

Fig. 3.

Terraces in hollow of Fall from Cliff.

For a distance of 2 miles from the Naze to Stone Point, at the entrance to Handford or Hamford Water, Walton and Stone marshes are protected by an earthen sea wall, with artificial works of a varied character, mainly faggoting, and rectangular groynes of wattling, requiring constant supervision. The arming of the sea slope of the wall is, in places, continuously of stake-piles set on edge, in parallel rows, above each other in steps. Seaward of the sand, yellow clay crops out, forming the foreshore, and London clay may be seen cropping through the sand, worn into forms like rocks; and, towards low water, near Stone Point, this water-worn clay appears in the form of black reefs. Here the sea is of a dark yellow tinge, over the shallows on each side of the entrance, sufficiently indicative of the waste going on, and of the material acted on.

Along the shore towards Stone Point, which thus derives its name, the sand becomes mixed with shingle, which ceases at the Point.

Handford Water forms a large tidal estuary of 3,000 acres area at high water, land-locked S.E. by the Naze, the neck of which peninsula at Walton is now only a furlong in width, and, like that on which Harwich stands, has become gradually thinner. The sea within the estuary during the ebb, retreats by numerous creeks, over the mud flats, the result of tidal deposit from the highly charged water; the creeks thus formed have left islands between their channels, and these have been gradually 'inoned' as they reached neap level. The main outfall runs from near Thorpe-le-Soken in a N.E. direction to Stone Point, and into it run two main tributaries, Walton Creek in a N.N.W. direction, joining the main channel at Stone Point, and Oakley Creek in a similar direction, higher up above Pewit Island. These combined creeks preserve a low-water channel of 7 fathoms, of which the 'North Sea Pilot' says:—

"Hamford Water is particularly available in north-easterly gales for vessels which have lost their anchors, and are unable to fetch into Harwich Harbour."

The least water below, at the entrance, is 7 feet at low water, at

$1\frac{1}{4}$ mile below Stone Point. The foreshores on each side of these creeks, and around the islands, are formed by a thick deposit of soft black mud: this is one of the recommendations of the estuary, as a place of refuge for weather-driven vessels missing Harwich, and liable to go ashore.

Between Handford Water and Harwich there appears to be a constant struggle to maintain the frontage. The sea-wall in front of the Oakley and Dovercourt marshes is frequently breached, and, at such weak places, it is repaired with 'arming.' Groynes are thrown out from time to time, and drifted sand lies on the summit of the broad flat foreshore at the foot of the earthen sea-walls. About the centre of the bay the sea-wall, for some distance, terminates, the marshes being protected by the remains of a range of sand-hills driven into the head of the bay. Towards Dovercourt, the sea defences become a thin, badly-formed bank of clay, formed of material irregularly, and apparently, hastily dug out from behind, with faggoting defences seaward, and occasional groynes, the general direction of the wall, N.E. $\frac{1}{2}$ E., and of the groynes, E. $\frac{1}{2}$ S., presenting an acute angle in a N.E. direction, in which a small amount of sand and septaria pebbles collects at the top.

Southward of Dovercourt, the sea defences are more regular in character, of large rough Kentish rag-stone, between parallel rows of faggots, the sea-wall terminating with a projecting mole, or breakwater out on the foreshore, parallel to the shore, in advance of the old wall, which it overlaps; and in the bight thus formed there is a local accumulation of sand. North of this is a complete pier, of similar construction, running out at right angles to the shore, with a curved end, and between these two moles are three inclined groynes; in the intervening space between these works and Dovercourt, the wall is irregular in direction, with trees sunk in the foreshore to act as breakwaters, and there is a large amount of drifted sand and sand hillocks at the top. At the north end of the bay are two old counter-walls at the back of the sand-drift. At Dovercourt the clay cliffs again crop out, and are artificially sloped and protected at the base, by a stone sea-wall. The curved slope first put up by Mr. Bagshaw, about twenty-five years back, was breached in several places, in 1860. The paving having become worn at one part of the north end of this wall, from a breach having been neglected, about 50 feet of the entire wall fell in, and the sea breached into the clay behind, to the entire breadth of the esplanade.¹

Towards the breakwater at Harwich, the sand of the foreshore

¹ Since completely restored.—J. B. R. July, 1865.

becomes mixed with fine shingle. Beacon Cliff appears to have first attracted attention about two centuries back, as may be seen by various papers in the "Philosophical Transactions." From a map of Harwich, of the time of Henry VIII. (Plate 2, Fig. 2), with forts proposed on Landguard and Beacon Cliff, there would appear to have been a large quantity of cement stones, (septaria) lying off Beacon Cliff, from whence so much has since been removed, and also off Landguard Point.

The Admiralty Chart of Harwich of the present day shows, that although scattered heaps of cement stone lie along the margin of Mill Bay, towards low water, none exist at Landguard.

In 1850, Beacon Cliff was artificially paved, and it forms the root of the breakwater. Along the north end of Mill Bay, as far as Mr. Bagshaw's boundary, the base of the cliff was artificially sloped and paved to 6 feet above high water, with a cess 10 feet wide, to form a promenade, and the clay of the cliff was formed to a slope above. Northward of the pier, it was treated in a similar manner. Between the breakwater and the old Low Lighthouse, numerous groynes run out below the stone slope at its northern end, nearly at right angles to the wall, some slightly inclined northward, the sand being highest on the south or sea side.

Walton Creek, on the opposite shore to Harwich, forms the base on which has formed Lunger, or Landguard Point, (Plate 2,

Fig. 4.

LANDGUARD POINT.—View from S.W. Horn, looking E.N.E.

Fig. 3,) the shifting of which is traceable by indications existing on its surface, as well as by a comparison of the Cotton Maps, those by Collins of a subsequent period, the Ordnance Survey now thirty years old, and the Admiralty Charts of the present time. The fore-

shore, adjoining the Ferry, is mainly sand covered with shingle. The Fort stands on a low mound, which is being eaten into by the sea, and both north and south of the Fort, on the W. side of the Point, the shingle is retreating on the concave side. This has induced the erection of groynes, in the neighbourhood of the Fort, the upper ends of which have gathered considerable 'fulls' of shingle.

Southward, between the new Trinity House Light and the Fort, the bluff end of the overlap of the sea-beach from the point, is met with, trending inward. The entire area of the point, seaward of the Fort, is clearly an accumulation of sea-sand and pebbles, partially grass grown, the 'fulls' forming ridges parallel to each other, and the intervening furrows being distinctly traceable. The modern overlap, or trending inward of the Point, has so altered the bearings of the entrance, as to induce the maintenance of a third light, by the Trinity Corporation on the spit, which the old lights did not clear; and the subsequent entire discontinuance of the latter having been rendered necessary, new lights have been erected south of Dovercourt.

Fig. 5.

LANDGUARD POINT.—S.W. Horn, looking S.W. by S. towards the Naze.

The formation of Landguard is somewhat different to that of Dungeness and other similar formations, as it is at the extreme projection, formed of sand and small shingle, worn into a rounded hummock, with little cliff-like edges, by the varying action of the sea. Off the extreme S.W. point, with a strong S.S.W. wind, there is a complete cross sea. Here, as elsewhere, though mostly small and fine, the largest pebbles are cast up to the summit. The same remark applies to the east side of the point, where there is a long slope of fine sand and pebbles, crowned at the

[1863-64. N.S.] 0

summit by a 'full' of shingle; the largest pebbles being between the crown and the grass-grown sand-drift at the back.

Fig. 6.

LANDGUARD POINT.—Outline of S.W. Horn.

Fig. 7.

LANDGUARD POINT.—Summit of Seaward End.

Between the Fort, and the new Light dwellings, the progressive westerly increase of the spit may be traced, in a series of parallel lines, marking its seaward extremity at various past periods. These meet the present margins in so rectangular a manner, as to show the way in which the wasting has proceeded eastward, and the increase, westward; the latter in effect resultant on the former, the successive rounded S.W. horns thus formed being intact. The rounded grass-grown 'fulls,' due south of the Fort, in a N. and S. direction, at right angles, nearly, to the immediate sea margin of

the point on the south side, show that the spit stretched much farther into the sea in that direction at an early period.

At the old graveyard, the easterly decrease is said, locally, to amount to from 500 yards to 600 yards in the last ten years. The burying-ground is now one-half gone; and the shore line intersects it on the diagonal; and as the entire square area is shown upon the Ordnance Survey, with a considerable belt of shingle beyond, an approximate idea of the decrease may be gained. In 1838, the distance, from the centre of the graveyard, to high-water mark, appears, by the Ordnance Survey, to have been $\frac{1}{2}$ a furlong. This would give an average annual decrease of 4.40 yards. Martello Tower O., south of the graveyard, the site of which is now entirely covered by the sea at high water, was removed in anticipation of this decrease.

The present Fort was erected in 1718. On its harbour, or west side there has also been a local decrease of shingle, amounting, in the last three or four years to 10 yards, and coincident with this, great quantities are removed, for ballasting ships, under the authority of the Lord of the Manor. Three series of groynes have been successively erected for the protection of this military post, but though they created local 'fulls,' the recession proceeds N. and S. of them as before described. There would thus appear to be a wasting on each side of the Point, or a 'thinning' process going on, and a corresponding elongation of the S.W. extremity, which in forming in this direction, is quite churned up by the waves; and there is a constant alteration of sectional outline with varying winds. As at Dungeness and Langley Points, there is, in connection with the extension, an eating away, chiefly on the weather side; the whole tending to show that Harwich is lapsing towards the condition of a bar harbour.

The entire area of the spit, landward of the Fort is formed of parallel 'fulls' of beach, clearly defined, as at Pevensey (Langley Point); but the nucleus is covered with fine turf. Where cart tracks exist, the shingle crops out. The ancient 'fulls' are parallel to the high-land, and at an acute angle to the present sea-margin; parallel to which latter, between the Fort and Tower P., is a large sea-mound, grass-grown, and 200 yards distant from the present shore; precisely similar to those which are found at Sandwich, in Kent. This ancient mole, as much behind as the present shingle 'fulls' are seaward of Tower P., shows the variations of the spit to have been constant, and to have extended over very distant periods. From the high ground between Martello Towers Q., Lower Walton, and Tower N., at Walton Ferry, the manner in which the Point has been formed may be traced. Barriers of sand and shingle, driven along the shore from the N.E., have gradually enclosed Walton Creek, in all probability the site of the

ancient outfall of the River Orwell. The overlaps of each formation may be traced in a western direction south of the Creek. Against these, outer marginal belts in a more N. and S. direction have been formed, curving, in a horn-like form, at the end of the spit, into the harbour.

The erection of the stone groyne, or breakwater, on the west side of Harwich Harbour, has had no influence on Landguard Point; and the question arises, whether extensive groynes eastward of Landguard, or a deep-water pier east of Bawdsey, would be a more effectual remedy? This however is very problematical, as the various surveys of Harwich Harbour, as well as the observations on the Point given above, show, that the action is to a great extent local, viz., a 'thinning' and extension of the point itself, which could only be checked by works confining the existing marginal outline of the spit.¹ A comparison of early plans with the present Admiralty charts of this Harbour, will show the continued retreat of the shore on the west side of the entrance, and the local extension westward of Landguard Point, which however at one period extended further seaward in a south-east direction. This extension of the spit in a westerly direction, the late Admiral Washington estimated in 1848, to have been at the rate of 10 yards per annum, or 400 yards in the 40 years prior to his Report; and he demonstrated that the sea had gained 80 yards, in a direct line, on the opposite western shore, or at the rate of 2 yards per annum; and that along the Felixtow shore, the rate of loss was further accelerated by the wholesale removal of cement stones, which formerly were barriers to the ravages of the sea.²

Bull Cliff is formed by the out-crop of the tertiary sands N.E. of Landguard. It is about 40 feet high, with small sand 'dunes' at its foot, a shingle beach beyond, and a sandy foreshore. The cliff declines to the shore, west of Bawdsey Haven, where a very large accumulation of modern shingle is met with. The groynes to the south-west of the battery, in front of Tower T. are buried in shingle and sand, and those more recently constructed hold large 'fulls' of shingle.

The entrance on the west side of Bawdsey Haven is flanked by

¹ By the Harwich Harbour Bill (10th May, 1865) a pier was proposed to be constructed on the Landguard inner beach, 1,200 feet N. of the Light dwellings or cottages, and extending in a west direction into the harbour 200 feet. The Harbour Conservancy Board have advertised for tenders for groynes, one to project in a south-east direction, 1,350 feet seaward of the Light dwellings, and another in the same direction 1,000 feet in length, at a point to the northward of the Fludyer's Arms inn, on Felixstow beach.

² The rate of progress still continues, the westerly tendency increasing, and the present S.W. extension of the spit defined on Plate. Fig. 3 was taken on the 3rd July, 1865.—J. B. R.

sand 'dunes' behind the shingle, in front of the salt marshes, in line with Towers T. and U., in advance of which is an immense accumulation of sand and shingle, 80 yards in breadth opposite Tower T. The shingle becomes steep on the curve into the harbour, and increases to a breadth of 150 yards between the two Towers. It is composed of seven series of parallel curved concentric 'fulls,' with a general direction N.N.E. The sand foreshore is hard and steep next the harbour's mouth. The moveable beacons on the crest of the beach, near Tower U., are sufficiently indicative of the fluctuating character of the entrance. Here, the shingle is reduced to 70 yards in breadth, with two modern 'fulls' in advance of grass-grown mounds. The modern 'fulls' tail round into the harbour on the west side, north of the houses adjoining the Ferry, in the usual horn-form, gathering inshore, above which is the western mud foreland of the River Deben. The east shore spit terminates in a similar manner immediately opposite. West of the haven's mouth, stretching far into the sea beyond the Black Buoy, may be seen an extensive triangular area of yellow shoal water; and immediately off the entrance two yellow island spits, dry at half-ebb, a prolongation of the beach from the north-east, through which the outfall waters cut intersecting channels. There is deep water to the west of these, trending round towards the coast line in a S.S.W. direction. Bawdsey Haven is available, as far as Woodbridge, for vessels up to 250 tons burthen, and of from 12 feet to 13 feet draught. The rise is 11 feet at springs and 7 feet at neaps, with 2 feet over the bar.

An extensive accumulation of drifted sand lies on the east side of the haven up to Bawdsey Cliff, which is about 50 feet in height, and falls much. The sea eats into the spit N.E. of the haven, and under the Cliff the shingle is narrow and thin, with a clay foreshore. Martello Tower V., formerly situate on the Cliff, has been pulled down, apparently in anticipation of the continued fall of the Cliff; and the battery which formerly existed outside of it is also gone. Eastward, the Cliff rises to about 100 feet in height, with constant deeply indented falls, continuing high until near Bawdsey sea-mark, where it declines towards Martello Towers W. and X. to about 20 feet. Between these Towers, at Boat House, or East End Point, the Cliff is only 8 or 10 feet high; the beach increasing to 60 yards in breadth, in two large 'fulls,' with fine shingle below, and a solid sandy foreshore.

Northward, the beach increases to two series, or four 'fulls,' and past Towers X., Y., and Z., there is a lofty beach, very similar to that at Kingsdown and Walmer, in Kent, from 100 yards to 200 yards in breadth, with ancient 'fulls' parallel to the present coastline close up to the low land. This beach bears N.E. by N., and is nearly straight for a mile and a quarter. There are three sets of

'fulls,' equal to six ridges of large beach; the largest cast up to the summit. An early sea-wall, grass-grown, a mile in length, is situate a long way back inland, between the shingle and the Towers; and the battery in front of Tower Y. is a long way inshore of the shingle. Between Towers Y. and Z., the back of the old beach is about 70 yards in advance of the old sea-wall. The old sea-beach is about 50 yards, and the modern shingle is about 100 yards in breadth. The lofty crest of this modern formation is very similar to that presented by Sandown Beach, in Kent, six years back, before it suffered so materially as it has done recently; and it is about 5 feet above the old sea-wall. Here, again, the

Fig. 8.

North Weir Point.—Sketch plan.

largest boulders are found on the crest, and, as is usually the case, the modern beach is the highest. Bawdsey Beach is the

overplus from Orford, formed in a bight favourable for its retention.

Northward, on to the outfall of the Rivers Ore and Alde, all is pure rolling beach, past Shingle Street—a collection of small Boatmen's Cabins on the beach. Here is a large horn of accumulated shingle, which, in its outline, becomes irregular near the outfall of the river. The largest pebbles are found cast on to the crest of the inner 'full,' between which and the outer modern

Fig. 9.

North Weir Point, looking S.W.

crest there is a deep gully, the site of the old entrance to the harbour, when at one period it was farther south, accounting for the local irregularity in the beach.

The 'North Sea Pilot' thus describes Orford Haven :—"The entrance is subject to frequent change, and there are persons now living whose memories go back to the time when it was $1\frac{1}{2}$ mile

westward of its present position; but wherever situated, its principal features remain the same.

"The extremity of the eastern beach is named the North Weir, or North Ear, below which are numerous detached banks of shingle termed the Haven Knolls, and through these the river maintains a channel, and generally a swatchway besides: 5 feet is the average depth over the bar at low water springs."

From this description, it would appear that the entrance was once near Tower Z., at the north end of Bawdsey Beach, and that the Haven Knolls formed portions of Orford Beach.

When this inspection was made, there was a main triangular bar of shingle across the entrance, and the shingle spits at the entrance were a long way out seaward into Hollesley Bay. North Weir Point, a huge mound of shingle, is the southern extremity of Orford Beach, and forms the north boundary to the entrance, from whence the mean bearing of the shore, looking south across the entrance, is S.W. 5° W., in the line of the triangular bar and mean shore line.

The sea slope is formed of fine shingle, very fluctuating, similar to Landguard, with an abrupt crest. North Weir Point is formed by a number of curved horns overlapping each other, with a deep hole at the nucleus, as in other similar formations. Without exception the largest pebbles are on the summits of the upper 'fulls,' and are found thrown over on to the back, or river slope.

The curved horns, which formed the termination of the beach at various periods of its formation, may be traced all along the beach from North Weir Point to the Boat House, distinctly defining the sites of former outfalls, and the progressive march of the shingle mole in a S.W. direction. The overlappings of what have been the successive terminations of the beach, are traceable step by step, the hollows between the successive ridges becoming grass-grown. About a dozen main 'fulls' parallel to and enclosing the course of the River Ore, may be counted along the crest of the formation, which attains an altitude at the summit of 10 feet above high water spring tides. Ascending higher up the river, ooze is deposited on the land or river side of the beach with small saltings near neap range.

ORFORDNESS.—This extraordinary mole of shingle is 10 miles in length, parallel to the shore, formed on the confluent channels of the Rivers Alde and Ore as its base. The general direction of Orford Beach to the south of the Ness is S.W., and northward, Alborough Beach bears N.N.E. Orfordness is formed of a series of curved concentric 'fulls,' sweeping round and forming a projecting point in advance of the general coast line, about 5 miles north of North Weir Point. The triangular projection thus

formed encloses salt marshes next the rivers. A remarkable and deep pool is found in the body of the beach between the High Light and the Marsh House, apparently the remains of a former outlet of these rivers.

Two views are given, taken from the summit of the High Light, which show the disposition of the shingle 'fulls,' and the manner in which the point has grown out, with the local variations and vicissitudes to which it has been subject. The first view (Fig. 10), is taken looking W. by S., in the direction of the main belts of modern shingle parallel to the present shore. Landward, these 'fulls' are 5 feet lower than those next the shore. Off the Marsh House, midway between the High Light and North Weir Point, and towards the 'Narrows,' there is a local twist, or change in direction, of every successive ridge of shingle. This has produced a series of hummocks east of Orford Water, opposite Orford Quay and Castle, having the appearance of horns, or bars, east of the old haven, precisely the position defined as the outfall in the Cotton maps of the time of Henry VIII.

ORFORDNESS, from the high Lighthouse to the Naze, looking S.W., showing a local twist in 'fulls,' E. of Orford Waters, like horns, or bars, E. of the Old Haven. The direction of the 'fulls,' along Holesley Bay, is E. by N. to W. by S.

Very large pebbles are found on the summits of these ancient 'fulls,' which become lower in-shore, and which, curving round

towards the broad water opposite the Castle, denote the successive southern terminations of the beach at early periods; each successive horn shutting in a deep valley between it and the beach upon which it has formed; these terminations still remain and are distinctly traceable.

The second view (Fig. 11) is taken looking N.E. by E., towards the extreme projection of the Ness and the Low Light. It shows the relative positions of the ancient and modern 'fulls' of shingle; the former in a direction due east, and the latter changing to E.N.E. $4\frac{1}{2}^{\circ}$ E. Outside, formed between the two Lights, and constituting the boundary between Hollesley, and Aldborough Bay, there is a modern projection of the Ness, of a brighter, yellower appearance than the rest of the mass. This accumulation, which is the growth of the last twenty years, is entirely local, and has been made in a series of convex curves overlapping each other, and forming a point of from 200 yards to 300 yards in extent.

Low Lighthouse.

Fig. 11.

ORFORDNESS, from the high Lighthouse looking N.E. by E., showing the modern spit of 18 years' growth, between Aldborough Bay N., and Hollesley Bay S., 200 yards to 300 yards in breadth seaward, the direction of the ancient 'fulls' W. to E., and near the high light-tower, W. by S. to E. by N.

The general formation of Orfordness is like Dungeness, and like it, has deep water close up to the point; and again, similar to

Langley Point, the ancient 'fulls' are intersected at an angle by modern formations. Very large flint boulders are found on the summit of the Ness behind the High Light. The local increase at the point has been accompanied, as in the former examples, by a corresponding decrease, viz. off the Low Light and towards Aldborough. In illustration of this, the present Low Light was formerly the High Light, and the old Low Light was situated E. by S. of it, some of the foundation piles of which were visible in the sea a few years since. The base of the tower and the connecting bridge have disappeared about four years. These remains extended to low-water mark. The present distance, from the High Light Tower, to high-water mark is 100 yards, and from the Low Light Tower 150 yards, and the old Low Light Tower was 300 yards east of the present Tower.¹

A chart of the coast of Suffolk, from Orwell Haven to Gorleston, of the time of Henry VIII., showing the various forts and beacons, when so much attention was paid to the question of coast defences, shows distinctly that the mouth of Orford Haven was then opposite the Castle. A chart of the time of Elizabeth (Plate 2, Fig. 4), from Bawdsey to Thorpe, shows a considerable southern progression, and county maps of Suffolk, of 1723 and 1787, also show this continued increase: North Weir Point is now opposite Hollesley. It was, half a century back, more than a mile still farther south, so that in three centuries the shingle appears to have travelled south-westward 5 miles, giving an average annual leeward progression of 30 yards. This rate must have been even greater over certain periods, as for some years past, the outlet has been stationary, or rather it has receded northwards, and forced its way through a weak part of the beach, or possibly through a partial breach caused by the sea.

Thorpe Ness forms the northern boundary of Aldborough Bay. It appears to have grown out to the extent of from 30 yards to 40 yards during the last few years. This may be seen by comparing the old and modern shingle, the relative sites of the boat capstans, and a comparison of the present margin, and that shown on the Ordnance maps. North of Thorpe, the shore recedes; the yellow sandy cliff is grass-grown, 20 feet to 30 feet in height, bounded by a belt of shingle 100 yards broad, diminishing in quantity towards Sizewell. Here the shingle increases, forming a spit, which has grown out in twenty years from the earlier grass-grown portion, in extent about 85 yards, equal to an annual increase of

¹ The present distance to the High Light Tower is 95 yards, and to the Low Light Tower only 115 yards, where there has been a local decrease, equal to 10 yards per annum; and northward there is an evident recent increased waste of the shore.—J. B. R., 5th July, 1865.

$4\frac{1}{4}$ yards; half a dozen parallel belts of shingle and sand line Sizewell Bay.¹

The enormous masses of sea-drifted material that fringe the shores just passed along, in parallel belts, for miles in extent, over many acres in breadth landward, at Landguard, Bawdsey, Orford, and Aldborough, to the present point, sufficiently attest the degradation of the N.E. shores for centuries past. All have one uniform leeward motion, and increase southward; and all are heaped up in parallel belts, representing the periods of time over which these changes have taken place.

Landguard Beach has an extreme length of—

		2 miles by $\frac{3}{4}$ mile greatest breadth.
Felixton Beach . . .	3 miles.	
Bawdsey Beach . . .	5 „ „	by $\frac{1}{4}$ mile extreme width.
Orford Beach . . .	5 „ „	by $\frac{1}{4}$ ditto.
Orfordness Beach . .	2 „ „	by $\frac{3}{4}$ ditto.
Aldborough Beach . .	3 „ „	by $\frac{1}{4}$ ditto.

All are portions of one continuous belt of shingle, 20 miles in length, from Aldborough to Landguard Point, which may be regarded as its southern extremity, or Shingle End; as the formation of that name opposite Sandwich, in Kent, is the eastern termination of the great southern belt of shingle, reviewed in the Paper on the South Coast in 1852.

From Sizewell Cliff to Minsmere Cliff, the intervening marsh Minsmere Level has a frontage of $2\frac{1}{4}$ miles next the sea, fringed by a wide belt of low drifted sand-hillocks a furlong broad, then two series of shingle, old, and modern, south of the sluice at the new drainage outfall; the sand-hills are 120 yards in width, the beach is 30 yards in width, with a sand foreshore beyond; the beach and sand-hills decrease northward; the latter are cut into, presenting serrated edges as at Sandown, in Kent, and elsewhere, where the modern beach is retreating upon the base formed by the early sand 'dunes;' those near the sluice, are cut into, so as to present a section of the sand-hills with edges standing 8 feet to 10 feet above the beach, heaped against their face. North of the outfall to Minsmere Cliff, the level is defended by a sea-wall behind the sand-hills, which continue to be encroached on with a thin shingle 'full' driven against them; these sand-hills now lie behind the projection of Minsmere Cliff; but as the latter falls, there will be a corresponding waste of the sand-hills. Northward of the bottom, beyond the Coastguard station, the cliff falls to such an

¹ At Sizewell and Minsmere there has been a considerable decrease of shingle, and groynes have been erected at the latter place.—J. B. R., 6th July, 1865.

extent as to cut off the old path. At Dunwich Heath, masses of crag and bright yellow sand may be seen sliding down the face of the cliff, which is, here, about 100 feet in height, and is intersected all the way to Dunwich, with parallel fissures, the foot of the cliff being strewn with dark mould and heather, brought down upon the fall of the crag. Two 'fulls' only of fine shingle skirt the base, on the broad sand foreshore; at one particular spot, south of Cliff House grounds, there is a deeply-indented honey-combed fall, about 20 yards on the face, and 10 yards deep.

DUNWICH.—The intersection of the path along Cliff House frontage, constantly recurring, shows the progressive fall of the cliff, which here becomes literally an inclined plane of sliding sand. It is lower towards the ruins of the old church of All Saints, 62 yards distant from its edge: south of this church, a groyne of stakes, across the foreshore, is evidence of attempts made to arrest the decay. The foreshore is sandy, with a thin beach covering, and narrow, there being but 20 yards from half-tide level to the shingle, and 30 yards of fine shingle in two 'fulls' at the base of the cliff, with deep water close in shore. The cliff is 50 feet in height, and consists of loam, crag, yellow sand, and marl; north of the church, near the signal-station, it declines suddenly into low marsh land as far as Southwold, which is bounded by a sandy bay, crowned by five beach 'fulls.' For 4 miles in front of Dunwich Bay, the shore is 100 yards broad, consisting of 40 yards of old, grass-grown shingle next the marsh land, 100 yards of modern shingle, and 20 yards of sand foreshore to half-tide level. At one place, near the centre of the bay, the crest of the beach is piled to prevent the sea flowing over. The shingle increases in breadth and height south of Southwold piers.

The outfall of the River Blyth forms a small tidal harbour at Southwold, confined, or rather attempted to be confined, through the shingle, by two small wooden piers, in a S.E. direction. A large mass of shingle is heaped up at the back of the South Pier, 100 yards in width in advance of the angle of the Marsh Bank, in four parallel 'fulls,' the inner ones of old standing. The crest of the beach is about 4 feet above the South Pier Head, which is half buried by the seaward 'full.' There is also a large accumulation of beach and sand within the entrance on the north side, formed of large boulder shingle, which passes the Pier Head and travels up the harbour. The North Pier has been recently extended to a similar distance as the South Pier, but the shingle from the northward is much in advance of it, and after passing the entrance, collects round the South Pier Head; in fact, under certain conditions of wind, the mouth of the harbour is entirely choked with shingle, and has been inaccessible to shipping for weeks together. This was the case in 1859, so that persons could walk across the mouth

of the harbour; and during the spring of 1860, the beach was driven across the entrance up to high-water mark by easterly winds. During the winter of the same year, the ferryman and others used to walk across the entrance for two or three weeks continuously. When it was blocked up by N.E. and E. winds, as they described it, 'you might sit on the pier heads, the beach forming a convenient footstool below.' The land-water accumulating behind was frozen over, so that the harbour was literally sealed up within and without. These facts sufficiently indicate the decayed condition of this port, and the necessity for a much greater extension of the piers into deep water. On a recent occasion the 'Woodland Lass,' the largest trader frequenting the port, drawing 9 feet of water, waited a fortnight outside, and was subsequently another fortnight in getting from the Pier Head to Breydon Quay; showing that the harbour channel requires improvement as much inside, as the access demands it outside. A schooner of 60 tons burthen, lying at the quay on the 17th October, 1861, was stated to be of the maximum tonnage of vessels frequenting this harbour, about which so much was reported and said before the Tidal Harbours Commission in 1845.

A spit of shingle, seaward of the North Pier Head, overlaps it, and spits lie off both pier heads. The proposal at present entertained by the harbour authorities to carry out the North Pier 200 feet in five years, at the rate of 40 feet per annum, will, in all probability, barely keep pace with the attendant accumulation of shingle from the northward.

The early condition of the shore is plainly shown by a drawing (Plate 2, Fig. 6) in the Cotton Collection, A.D. 1509-47,—when two arms of the sea flowed over Westwood Marshes at the back of Dunwich, and over Reydon Marshes and Buss Creek at the back of Southwold, with a common outlet at Walberswyck Gatway, which appeared at that time to have a fathom and a half of water under favourable conditions. The estuary was, however, even then liable to be choked up. This took place as early as 1328, by N. and N.E. winds prevailing, and the pent-up waters burst a new outlet, 2 miles farther north, which must have been at the end of Buss Creek. This again was choked up at the commencement of the reign of Henry IV. A cut was then made which existed until 1464; its continuance was ascribed to the influence of a bank on the S.E. side; but when this sand-bank was washed away, the outfall was subject to constant oscillation. A fourth haven, called Hammerston's Cut, was dug near the last, but was frequently choked by a sand-bank lying N.E. of it, called Passeley Sands, on which many persons perished. In 1589 it was resolved to make a new cut, but the men of Dunwich, Walberswyck, and Southwold each preferred their towns as the site; and it was ultimately

forcibly opened by the men of the latter place; this proceeding caused a lawsuit of ten years' standing, ultimately referred, in 1600, to the Attorney-General Cook. This mouth, having no artificial protection, was constantly stopped, and was almost useless from 1614 to 1618. The Commissioners for the Harbour obtained their first Act in 1747, and the piers were commenced in 1749. Between 1805 and 1818, it appears the haven was dug out thirteen times, or once a year. Subsequent to 1829, the harbour was somewhat improved, by the removal of shoals, and appears to have gone for ten years without being blocked up. All this shows, that, however injurious may have been the wholesale embanking of the marshes on each side of the river, so much insisted on before the Tidal Harbour Commission of 1845, still, owing to other causes, the harbour has been in a worse state in early times than now, as may be gathered from what was said of it by Gardner, the old historian of Dunwich.

The present condition of the haven is not materially altered. It has from 8 feet to 10 feet water at high-water springs, and 4 feet to 5 feet at neaps; with a small rise of tide, viz. 8 feet at springs. Still the bay is unencumbered with shoals, and there is deep water close up to the shore; so that a further development of its resources may be hoped for.

Northward of the harbour the beach lies in a N.E. direction, from the new north pier head to the signal station at Southwold, and is 70 yards in breadth, from the sea-wall in front of the Town Marshes, the earlier 'fulls' being grass-grown.

The town of Southwold¹ stands on a terrace cliff of crag and clay, sloped and campsheeted in places, with two good 'fulls' of shingle at the base, gathering out in width, and increasing in number in the bay towards the piers, which they tend constantly to overlap. Northward of the small Southwold promontory, the head of Buss Creek is protected by a sea-wall, flanked by a broad belt of shingle: northward, a shingle-belt 30 yards wide is formed against the base of the cliff at Easton Bavent,² which contests with Lowestoft, the honour of being the "extensio promontarium" of the Romans, and if so, a loss of from 2 miles to 3 miles must have

¹ This place suffered much during the winter gale of 1862. Large portions of the cliff were then washed down, and this was no doubt induced by the constant degradation of the cliff south of Covehithe Ness. Three lofty groynes have been erected—one finished and two partially so. They are not of a character to arrest the waste. The pier on the north side of the harbour has also been lengthened 60 feet. The entrance was, however, blocked up for three tides in the first week of July, 1865, and a vessel of 120 tons was lying ashore off the entrance on the 10th of that month.—J. B. R.

² The edge of the cliff is now 14 yards from the east angle of the farm buildings at Easton Bavent.—J. B. R., 10th July, 1865.

occurred since that period, which would account for the degradation at Dunwich, produced by this increased exposure. The 'North Sea Pilot,' says—

"The sea has made great ravages here, for, according to tradition, the easternmost point of England and the city of Easton Bavent formerly occupied a site abreast, which is now 2 miles from the land."

Stretching 2 miles northward of the small sandy cliff at Covehithe is Covehithe Ness, enclosing Benacre Broad, formed of sea-sand, now covered with gorze and fine turf over the entire surface. Three distinct ancient mounds of shingle may be traced. A walking cane pushed through the heather and rich mossy turf grates immediately upon the beach. Seaward there is a considerable area of sand-hills, and then a high mole of modern shingle, the sand-hills being separated from the ancient and modern shingle belts by two broad and deep parallel valleys. South of Benacre sluice, the following are the widths :—

200 yards ancient shingle in several parallel belts ;

150 „ sand-hills 30 feet high ;

30 „ upper 'fulls' of modern shingle, 10 feet
above high water ;

60 „ shingle and sand foreshore to half-tide range,

or, 440 yards in all south of Kessingland.

At the north end of the Ness, as is usual with these formations, the sand-hills increase in height on the windward side, and meet the low cliff at Sea Row ; the slope of which, towards Kessingland, is about 30 feet in height, covered with sand-drift and long grass, with a broad belt of shingle and sand at the base. The largest pebbles are here collected in quantities, and stacked at the foot of the cliff for building purposes.

At Pakefield the cliff is about 50 feet high. The yellow sand mixed with clay crops out at the base, and a deep chine exists at the Lighthouse.¹ The foreshore, of shingle and fine sand, is 70 yards broad. The cliff gradually declines from Pakefield and Kirkley to Lowestoft, with a broad belt of sandy foreshore stretching out towards the Ness.

No attempt will be made to describe the well-known character-

¹ This light is now discontinued, and a temporary light exhibited in lieu thereof at Kessingland, to mark the southern extension of the Newcome Sand ; new lights are also being erected at Corton as leading lights for Corton Gateway. A light is also being erected to define the seaward projection of Lowestoft Ness. These changes have been brought about by the southern movement of the sands.—J. B. R., July, 1865.

istics of Lowestoft harbour, beyond reverting to the fact, that its origin and its maintenance are equally artificial, for it was formed by means of a connecting cut and a lock into Lake Lothing, and its depth is kept up by constant dredging. Still, it is no ordinary feat to execute and maintain, on such a coast, a port possessing a depth of 12 feet at low water, 18 feet to 20 feet at high water of spring tides, and 10 feet at any period of tide, and into which have entered not only vessels of 400 tons burthen, but even a steamer of 700 tons burthen. The fleets of vessels that may be seen at the fish-curing houses, the tugs passing backwards and forwards with their fishing convoys; others with their fleets of mud-hopper barges, are all indicative of the enterprise called into existence by the introduction of modern capital and appliances.

The position of Lowestoft as a harbour is in some respects advantageous. Like Yarmouth, it has its outlying sands and intervening roads, though much more contracted in character, and it lies to the southward of the projecting Lowestoft Ness, — the roadstead being almost shut in from the projection of Covehithe Ness south, to Lowestoft Ness north, by the outlying Barnard, Newcome, and Holme Sands, for 7 miles in length, forming Lowestoft South Roads. Northward of the Ness, Lowestoft North Roads, of a similar length, are formed by the Holm and Corton Sands, joining Yarmouth Roads, which are again formed by the Scroby Sands. These combined roadsteads, 20 miles in extent, are well known to mariners navigating these dangerous shores, whose safety depends on a constant observance of the treacherous material forming a bulwark against the storm.

The recent change of the Stanford Floating Light, which was moored abreast of Lowestoft, to mark the north entrance of Stanford Channel, which has a north and south direction between the Newcome and Holme Sands, is sufficiently indicative of the shifting character of these sands. The necessity of moving this light northward to the Corton Gateway, arose from the Holm Sand outside the Stanford Channel tailing out $1\frac{1}{4}$ mile to the south. In fact the outlying sands grow out southward, corresponding with the movement of the littoral deposits, denoted by the tailing out of their southern extremities, the wasting away of their northern projections, and by the closing up, in some instances, of intervening and well-known gateways, or swatchways, used for navigation. Pakefield Gateway, south of Newcome Sand, has shifted 2 miles south, within the recollection of pilots of thirty years' standing.

At Lowestoft Ness, the foreshore is mainly sand. The entire upper surface on the south side, in the neighbourhood of the open timber Low Light Tower, is covered with white driven sand, of a flocculent character, shifting rapidly in every direction. Northward, below the sloping cliff on which the old town stands, are 'Denes'

[1863-64. N.S.]

1'

grass-grown, hillocks of drifted sand, covered with gorze bounding them next the sea. An ancient 'full' of sand and shingle, parallel to the cliff, is traceable within the angular accretion and projection of the Ness. At the point of the Ness commences a shingle 'full' of pebbles, the largest being on the crest. These are collected for building and road purposes, and measure 5 ins. $\times$ 3 ins. $\times$ 2 ins. Round the north-east elbow two 'fulls' of fine shingle make their appearance, and two early 'fulls' inside: then pure sand; the shingle reappearing southward at Pakefield, as before noticed. At the Point, the foreshore of sand and shingle is steep, and about 30 yards broad to low water; the navigable channel lying close in between the Ness and outlying Newcome and Holme Sands. There is deep water, 6 fathoms, close to the Ness, as is the characteristic of all these formations, so that it is the practice to throw whiting-lines from the shore, by which good fishing may be obtained. Across the 'Denes,' on the north side, opposite the boat-house, the following is a section of this remarkable spit:—

25 yards, sand and shingle foreshore, 7 to 1;
 6 " 'full' of recent shingle at high water;
 30 " sand and large blue pebbles up to grass-grown
 — sand 'Denes.'
 61 yards of shore seaward of 'Denes.'

These 'Denes' are flanked landward by a deep valley lying between them and another line of 'Denes' parallel to the cliff, at an angle to the present shore line, the whole being backed by yellow sand-cliffs gently sloped and covered with gorze, heather, moss, and ferns. Northward the shingle is less defined. From the sand hills seaward there is a long foreshore, to a regular slope of sand and pebbles 100 yards in breadth, down to low water. The shingle 'fulls' are local at the point of the Ness.

There have been considerable fluctuations in the Point of the Ness, during the last ten years, the general result being, a wasting of the shore on the weather or N.E. side, accompanied by a corresponding local increase on the leeward or S.W. side, producing a southern movement of the Point.

At Corton, the cliffs lose the protecting influence of the Ness, and falls recommence, but there is a large amount of drift-sand at their base. The village of Corton is now close to the cliff: roads are intersected and others stopped up, that are shown entire on the Ordnance Survey, and some of the large substantial farm-buildings close to the cliff have been pulled down in anticipation of its continued fall.¹ The cliff continues to fall and retreat

¹ This waste continues, and some temporary expedients have recently been adopted for the protection of the base of the cliff.—J. B. R., July, 1865.

close up to the commencement of Yarmouth South Pier at Gorleston, necessitating the advance of the angular curved outworks at the root of the pier, to counteract the tendency the Yarmouth waters always have had to run south under the cliff, which is increased by the sea eating into the angle outside, south-west of the South Pier.

The sands at Yarmouth, like those at Lowestoft, have been comparatively stationary for the last quarter of a century. They have a per centage of flint boulders, a large number of which have been used for making roads within an esplanade wall, in front of the new portion of the town, north of the Victoria Jetty. The extensive area of the 'Denes,'—used by the fishermen for drying their nets, and on which is the race-course, lying between the harbour channel and the sea, with a long sandy foreshore, and the entire site of the old town and of the Abbey Church of St. Nicholas, with its extensive burial-grounds—is all one vast deposit of sea-driven sand, formed across the outfalls of the Rivers Waveney and Yare: the joint outlets of these rivers run into the head of a large mere—Breydon Water,—the outlet of which, being joined by the River Bure, forms the harbour channel. This is constantly forced to the southward, by the accumulation of littoral sands from the north, and the struggle has always been to confine the outlet waters at the turn called the Brush, and to direct them out to sea, at right angles to the shore. When it is considered that this area of sand, 5 miles in length from Caistor Point to the piers, and half a mile wide, equal to 1,600 acres, has been formed across what was a large estuary during the occupation of the country by the Romans, some idea may be formed of the enormous accumulations that have taken place. (Plate 2, Fig. 5.) At Caistor on the north, and Burgh on the south, were stations: the remains of the last are very similar in character as well as position to those of Richborough in Kent, and both have been left by the sea under like conditions. The old town of Yarmouth was formerly on an island, with two outfall channels—one at Caistor, the other at Gorleston. The first was eventually abandoned, and the town consequently decreased on the north side, and extended southward. The Gorleston Channel, which was formerly subject to continual fluctuations, was, after much labour, rendered permanent; but this was not effected without the aid of Engineers from the low countries. Probably the 'Brush' derived its name from the brushwood used by the Dutch in their operations. In the reign of Edward the Confessor the two outfalls were, one between Yarmouth and Caistor, called 'Grub's Haven' and sometimes 'Cockle Water,' and the other 3 miles to 4 miles south of Yarmouth towards Corton, and there were six successive havens before the formation of the

present outlet in 1559. This harbour is now the most important on the coast, with 10 feet at low water, and employs five hundred vessels in the foreign and coasting trades. It is a great fishing rendezvous, and has a considerable inland trade, with prosperous ship-building yards. The tendency has always been for the north bar, north-east of the North Pier, to travel south across the entrance.¹

At Winterton, a broad belt of sand extends at half tide, outside the high water 'fulls' of sand and pebbles; the foreshore being 150 yards in breadth, from half-tide range, to the base of the outer range of sand hillocks. Past Winterton, Somerton, and Horsey, an extensive range of sand hillocks forms a barrier to the marshes. From Winterton to the Ness Point there is an outer and inner range; the land range low, that next the sea from 50 feet to 60 feet high, tossed into the wildest forms, with deep basins, and beach in the hollows. There is a sandy foreshore, 150 yards in breadth, with a shingle 'full' close up to the foot of the sand-hills. At the extreme north-east spit, of rounded sand foreshore, off the signal station east of Warren House, the sand-hills diminish in height, and shingle is driven through the interstices occurring in their outcrop where reduced by the sea. Northward, the 'full' of large pebbles increases in volume; the single range of sand-hills from the Ness Point to Waxham is of great height, about 70 feet, but nearly breached in places, with hurdle-work across the partial breaches, and small shingle driven right up the sea slopes.

The old tower of Eccles Church (Figs. 12 and 13) has been immortalized by Lyell. The sea slopes of the sand-hills are now behind the Round West Tower, which is washed by the sea at high water. The foot of the sand-slope was, in October 1861, 17 yards in advance, seaward, of the Tower before the foundations of the nave were seen; then 8 yards of the north wall appeared through the sand, the south foundation wall being buried in driven sand; the chancel foundations walls, 13 yards long by 8 yards broad, were completely uncovered. The old Tower is filled, at

¹ There has been a great increase in the littoral sands immediately abreast of the frontage of the town, but north at Caistor and south at Gorleston the waste has correspondingly increased, and the bar of the harbour has become more troublesome, with a loss of 18 inches of water at the entrance. The North Sand overlaps the entrance, and vessels drawing 16 feet of water are lightened in the Roads. A large American barque in the Roads, timber laden, was discharging into lighters on the 11th July, 1865.

The continued increase of the North Sand at the entrance to Yarmouth, and of the sands in front of the town and the new esplanade walls, which four years back stood considerably out of the sands, but are now buried therein, is attributable to the constant and continued degradation of the shore north-west of Caistor. A groyne at the last-named place is much wanted. The harbour of Yarmouth is now rapidly lapsing to the condition it was in half a century back, when 10 feet, and not 15 feet, was the maximum depth over the bar, and which is now reduced to 13 feet 6 inches.—J. B. R., July, 1865.

the base, with driven sand, which has found an entrance by the south door. The foundations of old houses may be seen cropping

Fig. 12.

Eccles.

Fig. 13.

Eccles.

out through the foreshore at low ebbs to the eastward of the Church. The summit of the Church Tower is level with the top of the sand-hills.¹

¹ The 'Marrams,' west of Eccles Church, have receded about 15 yards in the last three years, and in the neighbourhood of Palling; the shore suffering much during the gales and high tides of the last two years.—J. B. R., July, 1865.

Three quarters of a mile north-west of Eccles the 'Marrams,' which have been traced in almost an uninterrupted belt of 16 miles north of Yarmouth, terminate, the only break in their continuity being at Scratby Cliff. At Happisburgh the clay crops out, in low cliffs about 30 feet high. Past the Lighthouses, and the Preventive Station, they fall a good deal, and masses are to be seen projecting through the thin sand-covering of the foreshore. The Church, with a tower 127 feet in height, on a knoll, a short distance from the Cliff and 40 feet above it, presents, in its noble proportions and decorations, evidence alone of the enormous waste of the coast. It appears when the last portion of the hotel was built in 1803, it was a quarter of a mile, or 440 yards from the edge of the Cliff. In October 1861, it was 310 yards distant, or 130 yards less, in fifty-eight years, equal to an annual loss of $2\frac{1}{4}$ yards.¹ The 'North Sea Pilot' gives a higher result, viz. 2.83 yards per annum; and it is surmised that, should the present waste continue, this noble church and the village will have been swept into the sea by the middle of the ensuing century. This portion of the coast is remarkable for the number of its churches, leading to the inference that it was once more inland and more densely populated. From the High Light Tower, and from the hotel windows, no less than thirty-eight can be counted. The Lighthouses are half a mile south-east of the village, and are leading lights for Hasborough Gat, leading clear of all the outlying sands lying off Winterton and Yarmouth, also denoted by the Newarp Floating Light.

N. N. W. of Happisburgh, the cliffs, 50 feet to 60 feet high, fall much. They are of light yellow sand above, and of dark clay below. The waste is shown by the disappearance of the 'Summer House' north of the church, and the road thence to Ostend, both included in the Ordnance Map. This gives a decrease of $\frac{1}{2}$ a furlong, or from 3 yards to 4 yards per annum. The whole range of cliff here presents one continued series of slips. The earth fences enclosing large fields are intersected, leaving a series of small hillocks on the edge of the cliff. The loss at Walcot on the frontage of one farm is known to have been 40 yards in breadth in the last twenty years. The meeting of the roads north west of Ostend, a cottage,

¹ This distance is now 305 yards, but the waste of the cliff at the Preventive Station is greater, being estimated by the Coast-guard officers as equal to 10 yards in the past three years. The cliff at Happisburgh is only 20 feet to 30 feet, and looking at the character of the land and buildings, the question arises, whether it would not pay to convert it into a slope, and properly pave and drain it; agricultural operations, stripping the clay from settled portions, from the way in which they are conducted, must often hasten the decay.—J. B. R., July, 1865.

and a meeting of roads at Walcot Gap, shown in the Ordnance sheets, are all gone.¹

Towards Mundesley the yellow sand-cliffs, capped with 'crag,' rise to a height of 100 feet. They are of undulating outline, formed by the outcrop of the downs and valleys of the tertiary strata. In places, from the upper stratum of crag are to be seen sliding down the cliff face, masses of water-worn flints, so that the large boulders found on the shore are not modern, but diluvial shingle nearly 'in situ,' only at a lower level of from 50 feet to 100 feet. Here, the cliff face, in places is a complete avalanche of sand, loam, and gravel. S. E. of the small watering-place at Mundesley, the cliffs decline to 40 feet, or 50 feet, and the frontage of this bathing-place has been protected, by walling the face of the cliff.²

Fig. 14.

Coast S.E. of Mundesley.

The large angular bastion at the south end at the Flag Staff had recently fallen in October 1861, and three years prior, the lower

¹ The characteristic of the foreshore from Happisburgh to Mundesley is the great height of the sand, in two rounded 'fulls,' with a deep runlet between. The sand drifts against the cliff, and thus forms a natural protection. Six teams were actively employed in the afternoon of the 14th July, 1865, in removing this sand.—J. B. R.

² These walls are now a mass of ruins along the entire frontage; they appear, however, to have been a mere skin of flint-work, with few counterforts or bonds into the cliff. Here three or four teams were actively employed in removing the sand and the large flints which lie in the deep rivulet between the spring and neap sand 'fulls.'—J. B. R., July, 1865.

walls were also breached. The upper wall suffered in the same way during the winter of 1860. 'All Saints' church on the North Cliff, in its fallen tower, large nave partially enclosed, and roofless aisle, bears striking testimony to the decay around. The S. E. angle of this church was, in October 1861, between 70 yards and 80 yards from the edge of the cliff. On the Ordnance Map, this distance is $\frac{1}{2}$ a furlong, equal to a mean loss of $4\frac{3}{4}$ yards per annum. Northward of Mundesley, the farmers abandon ploughing close to the edge of the cliff, and have two fence banks, one next the edge, and the other connecting the heads of the chines; the intervening crescent-shaped belts between the slips forming rough grass enclosures.

Fig. 15.

Mundesley to Cromer. Isolated Chalk Peak.—Front View.

Fig. 16.

Mundesley to Cromer. Isolated Chalk Peak, from the S.

A mile and a quarter north of Mundesley, the chalk crops out, in a rounded boll very much contorted, the veins of flint being at a considerable angle. Shingle and sand are heaped up against its base, and it is capped by a lofty yellow sand-cliff. Two sketches are given (Figs. 15 and 16), the first looking full on, and the second northward of this exceptional stratification. This outcrop presents similar appearances at the present time, but has become

much discoloured on the face, from the constant slipping of sand from above; similar shoots of the cliff have taken place E. and W. of it. A similar outcrop of the chalk takes place two miles north of Mundesley. Northward the cliffs rise to 120 feet in height, of bright-yellow sand, very much contorted, with deep grass-grown chines. A ferruginous patch of highly contorted sand, and another peculiar isolated outcrop of the chalk, are met with. Between these two chalk points, the sand strata are twisted into the wildest conceivable forms, and avalanches of sand and clay occur. There is a steep sandy shore, with broad belts of gently declining sand to low water. Between the high water 'fulls' of sand, and the foreshore belt, there is a deposit of enormous flint boulders from the cliffs. These flints, 18 inches long and 6 inches in diameter, much beyond the ordinary size of modern littoral shingle, are, as before observed, diluvial pebbles, nearly 'in situ,' but dropped down some 100 feet by the wasting of the cliff. Here the chalk commences to crop out through the foreshore. S. E. of Trimmingham enormous masses of sand, 200 feet in extent on the slope, with two or three flint seams embedded near the top, may be seen. Some of these slips varying in extent from 5 acres each to 10 acres each, form an undercliff 70 feet below the present edge of the cliff.¹

Cromer has suffered much from the encroachments of the sea. It stands on the N.E. salient point of the county, and is open northward to the island of Spitzbergen. The present lighthouse stands at a height of 250 feet above high water, on the S.W. spur of the star-shaped cluster of downs, which have been severed by the continued inroads of the sea; and although the ground rises rapidly S.E. to the lighthouse, and also northward, the cliffs fronting the town are only from 30 feet to 40 feet high. The old lighthouse, erected in 1719, and abandoned in 1833, and formerly called 'Foulness,' is now only 5 yards from the edge of the cliff.² In front there is a great 'shoot,' or fall, with an undercliff of sand, loam, and gravel. The shore, not inaptly termed 'Foulness,' is bounded by chalk reefs beyond low water, as may be seen distinctly from the cliffs all along the coast. They are thus spoken of in the 'North Sea Pilot':—

"Foulness Rocks. The bottom in front of Cromer lighthouse
"is an extension of a bed of chalk underlying the mud
"cliffs; it is very uneven, and causes a high sea in
"gales."

¹ Here was picked up a large water-worn pebble of *granite*. The dark-blue clay forming the base of these cliffs, as may be seen in the split masses from the shoots, is full of water-worn chalk, pebbles, and flints. A mass of water-worn debris, when washed out of the clay, and again set rolling, would appear to be modern, and not diluvial.

² Present distance, 4 yards.—J. B. R., July, 1865.

The cliffs in this neighbourhood have, not very aptly, been termed 'Mud Cliffs,' for they are mainly of a bright sand, with immense deposits of water-worn flints in the upper seams of drift. Such a term would be more applicable to the Naze and Walton cliffs, where the London clay crops out in more defined masses. The position of the town is sufficiently indicative of the constant encroachments of the sea. Lying in a 'bottom,' the low cliff has only made a stand through artificial defences, which now form a point in advance of the cliff on either side. So large a church, so close to the cliff, without historical evidence, would be almost sufficient proof of waste. Its ruined aisle and chancel speak forcibly of the curtailment of the town. This place was anciently called Shipden, and as the 'North Sea Pilot' says, was,—

"of considerable extent and importance, but half of the town, including one of its churches, has been swept away
"by the sea."

Groynes are run across the shore in front of the town, three being eastward of the landing-jetty.¹ There are several fissures in the sea-walls; and northward of the town, the sand-cliffs fall to a considerable extent. The footpath northward is cut off, and the slips come close up to the coast road, which is marked some distance back in the Ordnance Sheets; nor do the 'Marram' hills, therein defined, now exist. The cliffs, which are 150 feet high, are composed of yellow sand above, much contorted, and blue clay below, the upper stratum containing a large mass of gravel. The general line of cliff east and west of Cromer, now bisects the town, midway between the sea-wall and the church, showing that the sea-side portion of the town is an artificially supported point. Westward, another isolated out-cropping peak of chalk occurs through the sand-cliffs, and west of that peak, one slip forms an inclined plane of sand, at an angle of 45°, from near the edge of the cliff to the foreshore. Advancing westward, masses of cliff, which have slipped bodily, are met with, resting half way down, and covered with herbage.

Between Runton and Beeston, the chalk, in places, forms nearly the entire height of the cliff; in other places the sand crops out, mixed with the chalk which readily falls. Beeston Hill is 50 feet above the cliff, or 250 feet in all, and commands an extensive sea-board view. The foot of this hill is now close to the edge of the Cliff. At some distance from it, a similar hummock to the westward (shown entire on the Ordnance Survey), is now cut in two, displaying contorted laminæ of sand, and alternations of sand and

¹ Additional groynes have recently been erected with more judgment than at Southwold, and have caused a large accumulation of sand and foreshore shingle.—
J. B. R., July, 1865.

flints. The diminution here thus appears to amount to from $\frac{1}{4}$ to $\frac{1}{3}$ of a furlong in twenty-three years, from 1838, the date of the Ordnance Survey, or an annual loss of from 2 to 3 yards.¹

Weybourn Beach commences, and now lines the shore, in a direction N.W. by W., in a continuous belt of 10 miles; assuming consecutively the name of Salthouse, Cley, and Blakeney Beaches, as it shuts in the 'saltings' (through which flow the harbours of those names), and terminating at the mouth of the last.

West of Cromer, the general southern leeward motion of the shingle, which has hitherto been traced along the coasts of Essex, Suffolk, and Norfolk, is now clearly reversed; and a local movement is found to the westward, due to the trend of the coast towards the Wash.²

Blakeney is at the best a mere tidal creek, through saltings enclosed by an outer natural barrier, formed parallel to the coast. The harbour is constantly deteriorating by deposit, hastened by the progressive enclosures for agricultural purposes. The great, comparative, rise of tide (15 feet), however, on this part of the coast, renders it an important local port, and it is available at the quay, for vessels of 200 tons burthen, and, in the harbour, of 300 tons burthen. Sixty tons appears to be the maximum tonnage for Cley, which is not available at neaps. On the 26th October, 1861, one hundred and twenty-four vessels were in the offing east of the harbours. The lofty tower of the church (104 feet high on the chalk downs), and which also has a curious open stone beacon lantern tower, is used by the pilots, some of whom aver that the movement of the harbour's mouth has been 500 yards within their recollection. The deep creeks which intersect the Moston, and Stiffkey marshes west of Blakeney, with the innumerable feeders running into them, well illustrate the conservative action of tidal agency alone, in preserving deep-water channels.

Between Blakeney and Wells, and thence westward to Brancaster, near the entrance to the Wash, a range of 'Marram' sand-hills forms an outer barrier at high water, parallel to the high land, enclosing tidal estuaries of considerable area, the low-water channels from which have formed harbours along this part of the coast from the earliest historic periods. The Morston and Stiffkey 'Marrams,' between Blakeney and Wells, are one mile within the

¹ The shore-works of defence off Beeston Church, commenced October, 1861, are now a mass of ruins. At Sherringham, flint and concrete walls, slopes, and groynes have recently been erected for the defence of the frontage of this large fishing-village.—J. B. R., July, 1865.

² The Weybourn beach has decreased of late years, and the sea was over the Salthouse and Cley levels two years back; the breaches, some of which cut clean down to the base of the wall, still remain.—J. B. R., 14th July, 1865.

Marram hills, which form the horn around the entrance to Blakeney Harbour, and west of Wells are 'Marrams,' which are a similar distance out, to those of Blakeney.

The sands rise in height towards the outfall of Wells harbour; shingle, mixed with sand, reappearing, thrown up from the north-east, in a crescent form against Wells 'Meals';—the base on which it forms, tailing round into the trumpet-mouth between Wells and Holkham 'Meals' at high water, called 'Wells Beach.' From this point it is, at low-water springs, 2 miles over the sands to the open sea at the harbour mouth, and nearly a similar distance up to Wells Quay.

Holkham 'Meals,' $\frac{3}{4}$ of a mile in length, in a crescent shape, from the spur at the Life-boat House on the west side of the harbour to Holkham Gap, enclose the sites of the West Fleet and Holkham salt marshes, which at one time formed the west 'lung' of the harbour, as the east is formed by the Lodge and Wells salt marshes. A straight sea wall, a mile in length from the west end of Wells quay to the east spur of Holkham, now encloses the western saltings, and the harbour channel has been straightened abreast of this work. The sea was over this enclosure two years back, when much damage was done elsewhere. An immense quantity of light flocculent sand is brought up this channel to the bend at the quay, and is deposited in a north and south direction, in spits overlapping each other. The low-water channel, below the quay, was, in October, 1861, choked by spits of sand lying transversely. At a drainage outfall, through the new wall $\frac{3}{4}$ of a mile down the channel, where the two arms of the low-water channel formerly separated, the channel took a sudden twist, or bend, to the eastward. This was said to have been projected 30 yards in the previous twelve months. The sand appeared also to be collecting on the face of the new wall, on the site of the space formerly situate between the two old channels. The immediate effect of this wall has been to increase the range of tide at the quay, and there is from 18 feet to 20 feet of water at the harbour entrance at H. W. springs, sometimes increased, with N.E. winds, to a depth of 25 feet. What is likely to be the ultimate result to the harbour will not be conjectured on this occasion.¹ The west channel at the outfall is the main one; that on the east is closing up. Holkham 'Meals' attain an altitude of 40 feet at the 'High Cape,' the most projecting hillock on the convex side of the curve. The sand is blown over the surface of the 'West Sands' at low water, with N.E.

¹ The present state of the harbour is reported to be good, and shingle has formed to a slope along the seaward face of the new wall.—J. B. R., 15th July, 1865.

winds, and attains a considerable height below the 'High Cape,' with an increasing high-water belt of shingle.

The tract of shore in front of Burnham Overy, Burnham Deepdale, and Brancaster, is of the wildest character; the 'meals' enclosing a tract of saltings, intersected by the creeks first named, and their tributaries. The saltings, only covered at extreme floods, in extent, 5 miles by 1 mile, or about 3,000 acres, are of irregular width; as the 'meals' enclosing Norton Creek are a mile in advance of those enclosing Brancaster Creek, where separated by the common low-water outfall channel, below Burnham Deepdale. Over the Ness, thus formed behind the 'meals,' the largest shingle is driven in spits, through chines. Behind the sand 'meals,' the Ness is, in one place, $1\frac{1}{2}$ mile in depth, from Scott Head to Norton Street. One great N. and S. spit of shingle, lying transversely to the general shore line, appears to define the range of wave behind the 'meals' from Burnham Creek. Another long spit of shingle stretches across the Ness N. by S. towards Brancaster Windmills, driven up from the eastward from Burnham Creek. In the same way, opposite Burnham Deepdale, shingle is found on both sides, seaward and landward of the 'meals.' Between the outfalls of Burnham, and of Brancaster there are, seaward, two well-defined shingle fulls, and a belt, 70 yards in breadth, of sand foreshore, which, during gales from E.N.E., to which it is peculiarly exposed, is strewn with flints. Lumps of chalk may be seen mixed with the flints, many of the latter, with their chalk matrix still adhering to them, showing the proximity of the source of supply. Here the 'meals' attain an extraordinary elevation; with the crater-like cups, or basins, peculiar to the largest sand-hills, invariably filled with the largest shingle; and the hillocks are here intersected by ravine-like depressions, forming sandy chines and peaks.

'Scott Head,' or as it is termed by the 'North Sea Pilot,' 'Scald Head,' is from 70 feet to 80 feet in height. From its summit, the seaboard eastward to Weybourn, and westward to Hunstanton, may be seen. The largest crater-like depression in this sand-hill is 100 yards long by 60 yards wide, and is 40 feet deep from the summit. Into this receptacle large shingle has been tossed in two 'fulls,' entirely above the ordinary shore shingle, at an elevation of about 30 feet above high water: a striking example of the great power of the sea. As a similar example, among numerous others, may be quoted, the second sand-hill, north of Battery No. 2, and immediately east of Sandwich, in Kent, where precisely the same phenomena may be observed.

Brancaster possesses great natural advantages; it has an outer road 4 miles long, and 1 mile wide, with a stiff clay bottom, and a depth at low water of from 3 fathoms to $3\frac{1}{2}$ fathoms, and a rise of

from 19 feet to 20 feet at spring tides, and of 11 feet at neap tides. The low-water creek, a mile and a half in length W. of Scott Head, runs through the sand foreshore, in a N. by E. and S. by W. direction, and has 9 feet of water at Brancaster Staith. Trade has, however, entirely left the place. On the east side of the harbour there is a small high-water ness of shingle, formed around the 'meals,' tailing inward: when this spit is rounded, there is a considerable recession in the shore (Brancaster Bay), where, even with a stiff N.E. breeze, the sea soon becomes comparatively smooth.

At Hunstanton, or St. Edmund's Point, there crops out, with a gentle rise from the E., an exceptional stratification of red and white chalk, a stratum of from 15 feet to 20 feet of loose rubbly white chalk, resting upon the red chalk, which is 4 feet above the sand and shingle, and which breaks off in nodules. There is very little shingle round the headland; the chalk falling in large slab-like masses. The red chalk appears to wear away the more rapidly, or is more exposed, and leaves the white in projecting shelves, these subsequently fall in large masses, strewing the shore. The edge of the cliff is at present 10 feet from the garden wall of the lighthouse, erected in 1840; since that period there have been no serious falls of the cliff, here about 60 feet high. The lower 5 feet is of black conglomerate, then follow 10 feet of red car stone, then 6 feet of red chalk, (green sand formation), and then 20 feet to 40 feet of white chalk, in hard horizontal slabs. The white chalk dies away to the southward, leaving red only; then that ceases, south of the new hotel, where there is a groyne, and where commences a low sandy foreshore, fringed with 'meals,' forming the east side of the Wash. South of Hunstanton, there is a well-defined belt of shingle, which has found a resting-place on the east side of the Wash, forming the sea barrier to the extensive tract of marshes below the high-land formerly overflowed by the sea. Southward, belts increase in breadth and number, and are difficult to trace, from being grass-grown and mixed up with the marsh. In position, these immense deposits of sea-drifted material are very similar to those collected at Sandown and Sandwich, in Kent, each formed under chalk promontories, and protecting large areas of marsh. This belt of shingle, extending from Hunstanton to Woolverton Creek, in an uninterrupted crest, except where intersected by creeks, is 8 miles long, formed on the summit of the 'Stubborn' sand, and it is curious that, in the majority of the numerous reports that have been written and published on the Wash Estuary, its existence has been almost ignored, and the whole of the littoral deposits have been treated as silt only. Woolverton Creek is at present the boundary of the Norfolk Estuary Works. Had the more extensive project ever been attempted, a travelling shingle would

have formed on, and run along, the walls towards the entrance.¹

Immediately south of Hunstanton, the low sandy foreshore has three groynes, across the upper part, at the foot of which is collected 'debris' of red and white chalk; the groynes retaining 'fulls' of sand and fine shingle, backed by low sand 'meals' fronting the Marsh. The third groyne, between the cliff and the rifle butt, retains a large amount of shingle, driven up the estuary by N.E. winds, and a general southern movement now prevails. The beach is 5 feet higher on the north than on the south side of the groyne, with those winds. In front of Heacham Park, between the shingle 'fulls' and the fallow, there is a belt of from 80 yards to 90 yards in breadth of ancient sea-beach, grass-grown; and between the creek, which runs more than a mile parallel to the shore, deflected upwards, and the present beach, there is a belt of grass-grown sand and shingle. At the outfall there is a lofty overlapping horn of shingle, and below, scattered over the foreshore, there are 'debris' of white and red chalk from Hunstanton. Above the creek, the shingle narrows, and there are numerous groynes projecting from the last, or outer sea-wall in advance of the saltings; 'fulls' of fine shingle being driven up between them over the saltings, which appear, of late years, to have retreated along this portion of the shore, many of these close-piled groynes standing quite out of the shore, 5 feet in height, with pebbles of the old shingle 'fulls' in the joints, and the piles bared in places down to the points.

A large ness of shingle has grown on Snettisham Creek, deflected more than a mile S., until it joins Woolverton Creek. Here there are four or five modern 'fulls'; then a series of ancient ridges, grass-grown, up to the meadow lands below Snettisham. A barn with farm buildings, erected in 1813, on the main marsh wall, is surrounded by a waved surface of ancient grass-grown shingle. All the low land, from Hunstanton past Heacham, Snettisham, Sandringham, down to Woolverton Creek, and towards Castle Rising, appears a ness of shingle, and back saltings formed on the various creeks, enclosed by it. It has the same appearance that is presented by all similar formations. The ancient 'fulls' are at an acute angle to the existing littoral belts: within this shingle belt, up to the spurs of the chalk downs at Heacham, and the Carstone formation southward, is a tract of marsh. The angular and older belts may be particularly traced where Woolverton Creek, after being joined by Snettisham Creek, retreats land-

¹ The area from which the sea has recently been excluded is the head or S. end of the 'Estuary' area, and only about one-fourth the distance above referred to.—J. B. R., 17th July, 1865.

ward towards Woolverton, and turns round subsequently toward the Wash. The triangular peninsula thus formed is entirely shingle, driving the Creek upwards.

In the recession of the high land between the spurs of the downs, at Snettisham and Woolverton, acres upon acres of beach may be traced. It appears to be the 'Shingle End' of this district. At right angles, nearly, to the crest of the present beach, nine spring 'fulls,' with intermediate neap 'fulls,' and their separating valleys, may be counted, partially grass-grown. Behind these there is another series, six in number, more solid, and grass-grown, up to the horse-shoe turn of the creek. All these 'fulls' terminate in horns, curling round inland to the eastward, and the intervening spaces between these overlaps become saltings. Some of these horns of shingle run in a great distance, right up to the bend of the creek, inland; the last has formed a series of eccentric double horns, or crescent curves, with a shorter radius. As each serial 'full' of shingle overlaps the last, the creek is driven upwards, at its outfall, and the low sandy foreshore and saltings, above, are proportionately impinged on. On the upper side of the creek, there is no stone whatever; but the well-known warp of the Wash Estuary alone. The range of spring tides is shown round the last horn, by a series of banks of shells, of crescent shape, formed on the shingle. The last horn has a steep bluff end, right into the creek side, like the end of an artificial mole, the base of the slope terminating at the creek. The shingle that has thus crept, snake-like, up shore, in parallel bands, has hitherto found a place of rest on the marshy foreshore. It becomes an interesting question, where it will ultimately deposit, if the 'Peter Black' sands are 'inned' down to Woolverton Creek.

This Paper is illustrated by a series of diagrams from which Plate 2 (Figs. 1 to 5) and the Woodcuts (Figs. 1 to 16) have been compiled.

¹ This return shows a recovery of the tonnage to the amount shown by the Returns of 1856.

THE EAST COAST OF ENGLAND.
FROM THE THAMES TO THE WASH.

Fig. 1.
SKETCH MAP OF COAST.

Fig. 2.
A CHART OF ORWELL HAVEN OR RATHER HARWICH ROAD SHEWING PROJECTED FORTIFICATIONS
BY HEN. LEE. 25th MEN. 87th (1637) COTTON M.S.S.

Fig. 3.
LANDGUARD POINT
COMPARATIVE STATES OF-

Fig. 4.

Fig. 6.
SOUTHWOLD HARBOUR.
COTTON M.S.S. TIME MEN. 87th A.D. 1509.47.

Fig. 5.
ANCIENT CONDITION OF THE WATERS NOW FORMING YARMOUTH HAVEN.
A.D. 1000. FROM IVE'S CARIANONUM.