# THE SUFFOLK COAST: ORFORD NESS.

By J. A. Steers.

## Introductory.

[*In a paper published in this Journal last year I described some of the changes which have taken place along the Suffolk Shore between Yarmouth and Aldeburgh. In the present paper the evolution and structure of Orford Ness forms the main theme. There are also a few general remarks on the East Anglian Coast as a whole—with more particular reference to the Suffolk part of it. In the main this paper is based on two other publications on the East Anglian Shoreline:* (1) *"Orford Ness, A Study in Coastal Physiography," which appeared in the Proceedings of the Geologists' Association, Vol. XXXVII.*, 1926, 306-325; *and* (2) *"The East Anglian Coast," printed in The Geographical Journal for January*, 1927. *Hence the present paper includes no new matter, but is rewritten here at the request of the Editor and Literary Committee of the Suffolk Institute of Archæology. Part I. is of a general nature and Part III. deals with Orford Ness. The paper published last year may be called Part II.*]

## Part I.

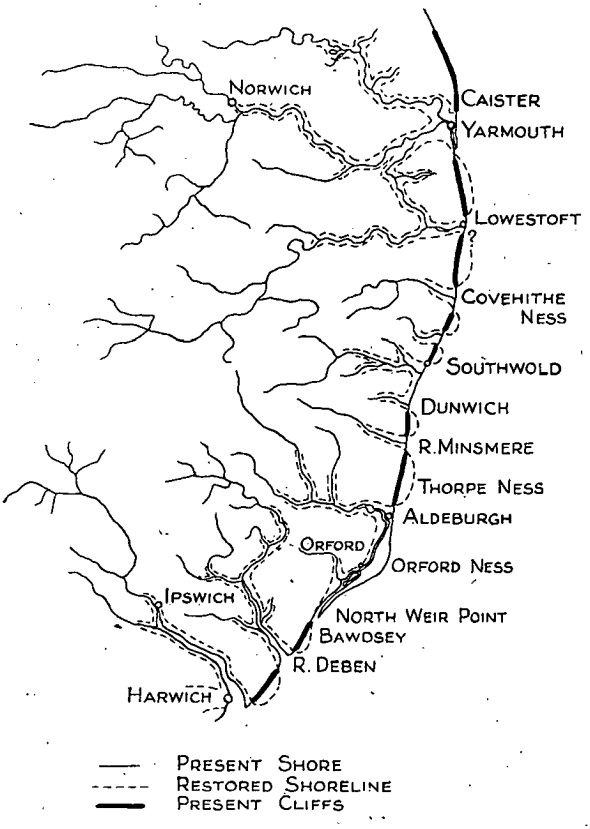
### The Evolution of the Suffolk Shore.

East Anglia is essentially an area of weak rocks, and is often quoted as an excellent example of a submerged low coast. This submergence, due either to a rise in sea-level or a sinking of the land, was probably completed in Neolithic times. The actual cause of the submergence is rather debatable, but beyond

suggesting it is almost certainly to be connected with the closing stages of the Quaternary Ice Age we need not concern ourselves with it here.

After its completion the Suffolk Coast was very different from what it is now. The characteristic smoothness of the present day was replaced by a great irregularity. The sea flowed up long inlets, and where we now find cliffs the land projected further seawards. Reconstructions of former periods are always difficult, and even in so recent a period as that of which we are speaking many difficulties are likely to arise in attempting them. It is well known that erosion is very strong on many stretches of the Suffolk Coast, and many suggestions have been made as to how much land has disappeared. Without doubt, much has gone, but in all probability most estimations are exaggerated. Naturally the disappearance of valuable land or of buildings as a result of ravages of the sea is a matter which excites a good deal of comment. On the other hand the natural or artificial reclamation of land often passes almost unnoticed. Natural formations may even be distinctly harmful in certain respects. For example, the rapid growth of Orford Ness was no asset to the port of Orford. On the other hand the marshes now enclosed by the shingle there form valuable grazing grounds.

To a greater or less extent this sort of thing has been taking place on the Suffolk coast since Neolithic times. In Fig. 1 an attempted reconstruction is made. In making such a map two main factors are of great importance. First the drowned valleys, secondly the lines of cliff. We are certainly safe in assuming that the sea formerly ran a long way up the many small valleys. Precisely how far it is difficult to say, but the dotted lines on the map are probably conservative estimates. It is more difficult to know how far to




Attempted reconstruction of the Suffolk Shore as it appeared immediately after the Neolithic submergence. The drowned valleys are shown by broken lines.

Fig. 1.

extend the present cliffed areas. Estimates made by different people would vary enormously, and the lines shown must be taken purely and simply as an indication of the former appearance of the coast, and not in the least as indicating *known* losses of land.

However, the map serves to bring out the general topography of the former shore, and shows a very striking contrast to the present smooth outline. The reasons for this great change are not far to seek. The rocks of East Suffolk are "weak." They consist very largely of Glacial Deposits—sands, clays, gravels, etc. —covering the Crags. Just at the mouth of the Deben occurs an outcrop of the London Clay. But none of these offered any great resistance to the attack of the sea. The numerous promontories of these soft rocks were soon attacked and were gradually cut back. In earlier times the cutting was probably quicker than now because there is every reason for supposing that the coast was lower. But the material supplied by this erosion soon formed an important factor in Suffolk coastal geography. All along the East Anglian coast, from near Sheringham, there is a southward directed drift of beach material. This drift is due to two causes at least : the general set of the flood tide here is southerly, and also the greatest area of open water is to the north and east. From off this stretch of water waves approach to the south and west, thus causing southerly directed beach drifting which in its turn caused the deflection of the larger rivers and the blocking of the smaller streams. Possibly there are other less important reasons, but these are sufficient in themselves to have brought about the differences between the maps of Neolithic and modern times.

One other point should be noted. South of the Deben and as far as the Thames the East Anglian coast is much more irregular than it is to the north of

the Deben. We may suggest two possible reasons to account for this. The submergence of this coast may not have been equal everywhere. The southern portion may have sunk more than the northern. If this were the case it is to be expected that the spits and bars would not have had time to develop so fully to the south as they have to the north of the Deben. A similar result, however, may be produced without appealing to unequal submergence. We have said above that waves and littoral drift are driving beach material southwards. The present irregularity of Essex may, therefore, be due to the fact that these two agents, tides and waves, have not yet had time to carry sufficient material southwards to deflect or to block back the many large estuaries of Essex.

## Part II.

### Orford Ness: General Description.

The effect of waves and drift on the Suffolk Shore has been to deflect river channels or even to block them up completely, as well as to cut back promontories. All the Suffolk rivers are blocked or deflected to greater or less extent, but the best example is that of the Ore or Alde. Here the river has been deflected for about eleven miles by a gigantic shingle bar. Not only is this the finest example of river deflection in East Anglia from the point of view of size, but it is also the most interesting case. It is possible to study the stages of growth of this bar in great detail. This is so because the bar is practically all shingle which is arranged in ridges and valleys. These ridges are called fulls and the valleys swales or slashes. Further there are many ancient maps of this part of the coast which afford corroborative evidence of its rapid leeward growth. Orford Ness, *sensu stricto*, is the name given to the apex of the bar, i.e., the Lighthouse Point. North of the lighthouse the beach is called Sudbourne

Beach, and South of the Lighthouse, Orford Beach. The southern extremity of the bar is named North Weir Point. The bar is continued across the mouth of the Ore by shingle banks or knolls into the great masses of pebbles piled up on to the marshes at Shingle Street. The haven mouth is naturally subject to great fluctuations even at the present time. The long tapering end of Orford Beach is very unstable and much damage may and often does occur in storms.

The width of the shingle bar varies a good deal. At Slaughden it is about fifty or sixty yards wide. Traced southwards it may be said gradually to widen as far as Orford Ness where it is about half a mile wide. From here up to North Weir Point the width again decreases to some sixty yards or so. Within the shingle are extensive marsh lands which have grown up *pari passu* with the shingle. These marshes have now been "inned" and form valuable pasture lands. The marshes are much cut up by creeks and dykes, the chief of which is the Stonyditch or Stone Eye. Old maps suggest that this creek and that one now forming the eastern boundary of the Lantern marshes were formerly connected.

The river Ore is now tidal as far as Snape Bridge, and forms a beautiful example of a drowned valley. Between Snape and Aldeburgh the river widens out and forms a large expanse of water at high tide. It may be remarked here that high water inside river at Slaughden is about an hour and a half later than on the foreshore.

This great bar of shingle has deflected not only the Ore but also the small, but very picturesque, Butley river. This stream is tidal up to Butley Mills; for the greater part of its course. A great volume of water collects in the rivers at high-tide, and, hence, with a falling tide the water runs out of Orford Haven at a

great pace, reaching seven or eight knots under favourable circumstances. The force of the stream is often sufficient to drive pebbles along the bed of the river. Anchorages are impossible just within the haven at this state of the tide.

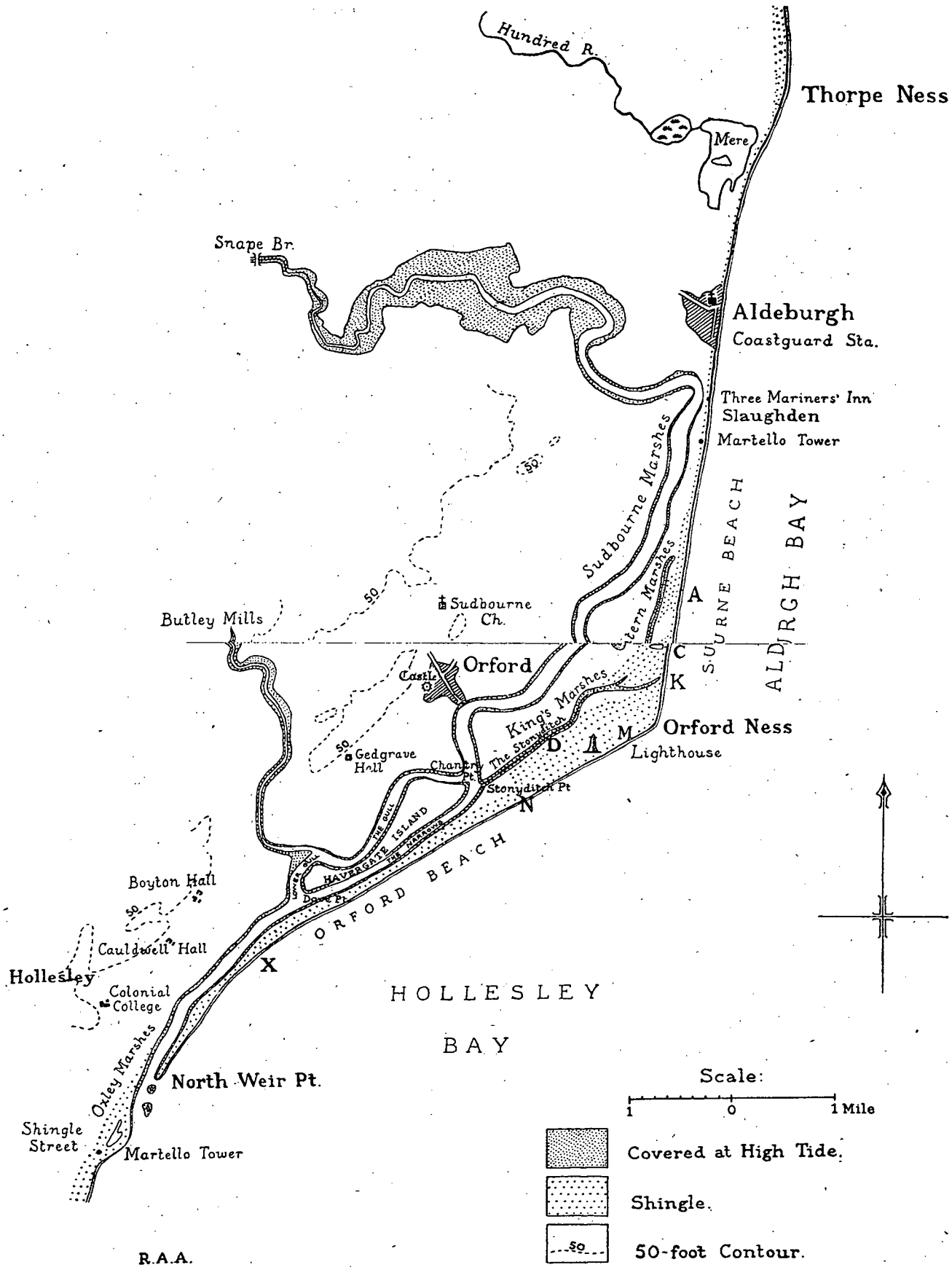
## The Fulls.

Before proceeding with an account of the evolution of the beach it will be convenient here to give a short account of the nature and disposition of the fulls. It is by a study of the fulls that the evolution of the beach can be worked out. Each full was built by wave action, and so each full represents a former stage in the growth of the main bar. A casual inspection of the bar from some viewpoint—e.g., the balcony of the Lighthouse—shews at once that the fulls are arranged in no haphazard way. For purposes of description we must refer to the map (Fig. 2). On looking north from the Lighthouse three main groups of fulls, which are labelled respectively A, B and C on the map, can be seen. Each of these groups consists of a large number of individual fulls or ridges, which meet the main Sudbourne Beach ridge obliquely. Generalizing for the groups as units, we find that group A bears 206° (T.B.), group B 216° (T.B.), and that group C makes an angle of about 56° with the main beach ridge.

Immediately south of group C is a very complex system of ridges. For convenience' sake they may be grouped as follows :—

1. The main beach ridge. It may be remarked that this ridge is continuous throughout the whole length of the bar, from Aldeburgh to Orford Haven.

2. Within this ridge and on the sea-side of the lighthouse are several ridges running more or less parallel to it. These have been named the Redman ridges




Reproduced by permission of the Council of the Geologists' Association from Proc. Geol. Assoc., Vol. XXXVII. (1926)

Fig. 2

after J. B. Redman who described them in the middle of last century.

3. The ridges on the land side of the lighthouse. These ridges run obliquely into the main beach ridge between M and K (see map), but south of the lighthouse are in rough alignment with it. Many of the members of this third group of ridges end near Stonyditch Point ; the remainder run on in approximate parallelism with the Orford Beach ridge for considerable distances, but sooner or later die out.

The long narrow part of the bar south of Stonyditch Point is comparatively new and possesses several interesting features. On the river side are numerous examples of recurved ends. These " ends " are all former terminations of the main beach. They often occur singly, but may be in groups. The far end of the spit is composed of much " fresher " shingle than the remainder. This can be seen very clearly because this newer shingle is not grass covered, whereas much of the older part of Orford Beach is grass covered. The older grass-covered ridges were obliquely cut into by the sea and the new uncovered shingle added later. This new shingle consists of a main ridge, in direct continuation with the main beach ridge mentioned above, with many perfect examples of recurved ends on its inner side.

Many of the older fulls on Orford Ness are grass covered. For various reasons vegetation favours the tops of the ridges and bottoms of the swales. Hence the lines of vegetation are, generally speaking, those of the ridges as well. Another point of interest in the ridges is the arrangement of the pebbles in them. Broadly speaking the higher and lower parts of a ridge are composed of larger pebbles than the mid parts. This is due mainly to the action of waves which can

drive the bigger pebbles up to the crest of a ridge. Some of these larger pebbles will find a lodgment, the others will fall back and collect at the foot. Since the older ridges have often lost their true ridge-form and are now much flattened, this arrangement of large and small pebbles is a great help in tracing the average direction of a group of fulls.

## The Development of the Bar in Recent Times.

Several maps of very great interest exist of this part of the English coast. From a study of these maps it is possible to estimate roughly the rate of growth of the bar. Simple measurements from the maps are not safe. Many of the older maps are very inaccurate and must be used critically. Then again some of the later maps cannot possibly represent the bar as it was in those times; they are "throw backs," as it were, and shew the coast as it may have been some centuries before their appearance. They may have been copied from older maps.

The earliest map extant is of the time of Henry VIII. Before this time we can only indicate the general nature of the growth of the bar; no definite dates can be given. Before reviewing the actual maps it will, perhaps, be useful to note one or two points about the position of Orford town. In mediæval times Orford was a port of no small note. Now it is a small village seldom reached by vessels. The rise of Orford as a port corresponded very closely with the building of Orford Castle in 1165. This point has been made by several writers: "Orford in 1164 was a thriving village, having a busy market-place. The erection of a castle increased its prosperity, and converted the once small hamlet of Sudbourne into one of the most flourishing of Suffolk boroughs." (Balding and Turner in Mems. of Old Suffolk, Ch. V.)

" When Henry II. built his castle at Orford in 1165 shingle had begun to collect at and upon the headland, Orford Ness. The town quickly developed from the small hamlet of Sudbourne to a thriving port, and finally to a flourishing borough *standing at the very mouth of the haven.*" (Redstone ibid. Ch. XII.)*

But for a thriving port to develop it follows that the haven was not then obstructed by shingle. The quotation immediately above is very instructive in this respect ; the words in italics give the key. In 1165 Orford was protected, not obstructed, by the shingle bar. Ships could come and go freely. The question now arises—Can we fix on a modern map the position of the North Weir Point of that time ? It has been stated earlier in the paper that a number of old shingle ridges end at Stonyditch Point. This in turn implies a long halt in the growth of the bar as a whole. A glance at the map will shew clearly the relative positions of Orford and Stonyditch Point. The bar had grown sufficiently far south to be a serviceable protection to Orford from north and east storms, but there was open water to the south and Orford was in a very safe position for a port in those days. It seems only reasonable to conclude that what we now call Stonyditch Point was in the twelfth century the southernmost point of the bar, the equivalent of the present North Weir Point. To strengthen this contention two other quotations are apposite. " The shingle travelled and accumulated over the Lanterne and King's Marshes . . . until a " New Mere " or shingle bar was formed across " Newmouth " at the spot where the Stone Eye entered Orford Haven " (Redstone ibid. Ch. XII). Further, in a personal communication Redstone writes " In the year 1237 the Lord of the Manor of Aldeburgh held right of the wreck of the sea from Almouth to Orford Ness ; the

*The italics are mine.—Author.

bailiffs of Orford from the Ness as far as Newmore . . . It is well to notice that the claims of the bailiffs of Orford do not extend south of Newmore, a name corresponding to Newmouth, the New Mouth of the River Alde given in opposition to the name Almouth or Old Mouth near Thorpe." (See also *The Butley Cartulary* and a note in the paper published in these *Proceedings* last year).

These several quotations and the evidence on the bar itself appear to leave no reasonable doubt of the contention stated above.

If now we examine the oldest of the maps we meet with difficulties. Fig. 3 shews a portion of the Henry VIII. map. The whole map extends from the Orwell to Gorleston and was probably prepared in connection with coast defence schemes. The map certainly shows the entrance to Orford Haven close to what is now called Stonyditch Point. It should also be noted, however, that the creek itself is not depicted. The map is very rough and obviously cannot be relied upon to any extent. No date is given, but there is reason for believing that it appeared about 1530.

Before drawing any deductions from this chart, let us examine carefully the succeeding maps. The first is of the time of Elizabeth and although not dated we may assign 1590 as an approximate date. There are many differences from the earlier map. Havergate Island is shewn for the first time ; the Stonyditch separates the Lantern and King's Marshes. More detail is given, and, most important of all, the "North Ende Poynte" (=North Weir Point) is shewn much further south, in fact, in a position which would correspond on a modern map with a place midway between Boyton and Cauldwell Halls. (See X on

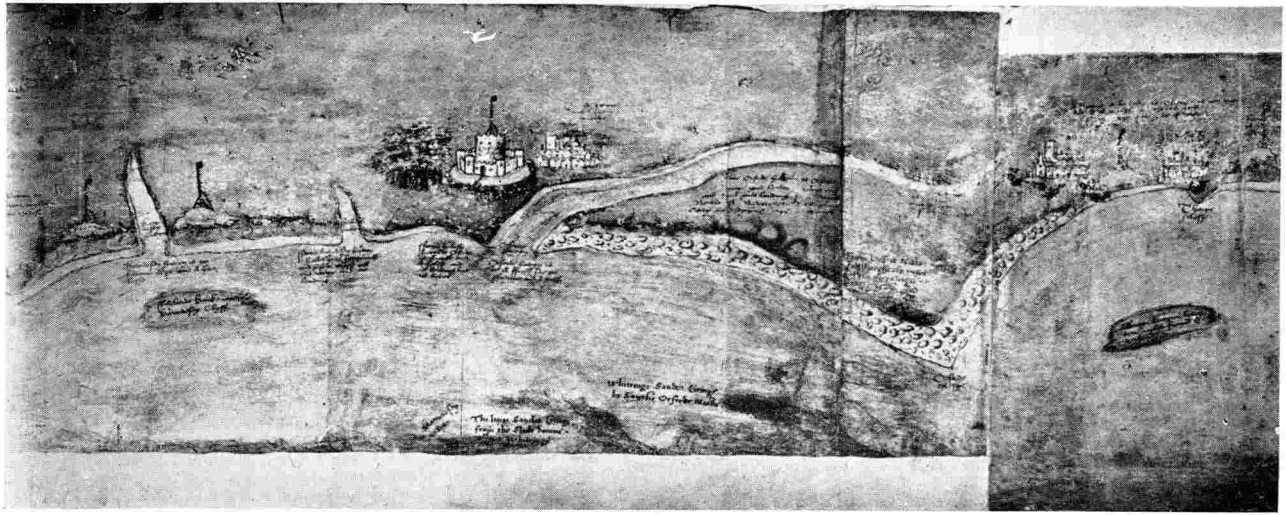


Fig. 3.
THE HENRY VIII. MAP.
Cotton M.S.S. British Museum.
Photograph of part of the Original Map.
The whole chart includes the Coast from Orwell Haven to Gorleston.

map). Further, the Butley Creek is overlapped by the bar, whereas it is not in the Henry VIII. map.

The next map is Appleton's, and is dated 1588. It is difficult to say if this preceded or succeeded the "Elizabethan" map. Both, however, are very similar and one may have been copied from or based on the other. They agree very well in most respects, and both shew the upper waters of the Alde in wrong orientation.

We next meet Norden's Chart of the River Ore. This is an admirable map and is of the utmost importance in our argument. The original map is drawn on 28 vellum sheets, each measuring 21 by 15 inches. Norden was a cartographer of high reputation and we may rely on this map more than upon any of the earlier maps. It contains a wealth of detail and the main features of a modern map are all shewn. Havergate Island (Mr. Hasset's Marshes) is shewn and also the channel known as the Gull. The Stonyditch and the creeks in the Lantern Marshes are carefully drawn. The orientation of the river is more or less correct. Finally the North Weir Point is well south of the Butley Creek. The map is dated 1601 and a comparison with the "Elizabethan" map, allowing for the incorrect orientation of the latter, shews that the position of the North Weir Point is in much the same place on each map.

Going back a few years we find Saxton's chart of 1575. This is very different from some of the other maps of the period. The outline of the coast at and around Orford is rather diagrammatic and is suggestive of the appearance of the coast at a much earlier date. The Stonyditch is shewn, and in this and other respects it does not agree with the Henry VIII. map. Both, however, agree in shewing the mouth of the haven in much the same position relative to the site of Orford.

Speed's map (1610) is practically a reproduction of Saxton's in so far as this part of the coast is concerned. Janson's map, 1646, and Overton's map, 1713, are, in general, rather similar to Speed's and Saxton's maps.

Maps of the seventeenth and eighteenth centuries all shew the progressive southward growth of the bar. The two Kirby maps of 1736 and 1766 shew the North Weir Point of those days to be nearly due east of Hollesley. Bowen's map (mid. XVIIIth cent.) agrees in some respects with the Kirby maps. Grenville Collins' Chart of 1764 also agrees with this southward growth. It is to be regretted that the chart is drawn on such a small scale. In 1805 appeared the first edition of the One-inch Ordnance Survey Map of this district. It shews the bar as having a greater width and rather more irregular in form than is shewn on subsequent maps. North Weir Point is shewn about 300 yards south of a line drawn due east from Hollesley Church. Although this map may not possess the great accuracy of the later editions of the Ordnance Survey, it certainly may be relied upon much more than any previous map, and for our present purpose may be considered correct.

In 1824-25 Bryant published a map of Suffolk, apparently from an actual survey made by himself. This map shews a slight southward progression of the beach and is in general agreement with the Ordnance Survey Map of 1805.

The next Ordnance map is dated 1838 ; the position of North Weir Point is practically the same as on Bryant's map, but the beach is prolonged in a series of knolls similar to those which obstruct the entrance at the present time (1923). The most southerly knoll is as far south as the Martello Tower A.A., that is the tower just to the south of Shingle Street. By

1893 the bar had extended as far south as the Coast Guard Station at Shingle Street. No knolls are shewn on this map ; those shewn on the 1838 edition having, apparently, become incorporated in the bar itself. By 1902 erosion had shortened the bar. In that year the North Weir Point was almost due east of Oxley House : two knolls are depicted.. In March, 1923, North Weir Point was nearly due east of the Colonial College, and the appearance of the shingle suggested the bar had been growing once again. The last two or three hundred yards were built up of clean shingle, and joined the older grass-covered ridges rather abruptly.

We have now reviewed the growth of the bar as shewn on maps. From this review we may draw some rough conclusions as to its rate of growth, and obtain some indirect evidence bearing upon the Henry VIII. map. Redman (Proc. Inst. Civ. Engs., Vol. 23) also made some estimates of the rate of growth of this bar, and found that an annual leeward progression of 30 yards was probable. This conclusion appears to be based on

(1) The Henry VIII. Map, and

(2) a statement which appeared in the earliest edition of the " North Sea Pilot " (and which is still reprinted) to the effect that : " The entrance (of the Haven) is subject to frequent change, and there are persons now living whose memories go back to the time when it was $1\frac{1}{2}$ miles westward of its present position . . . ."

The first edition of this publication appeared in 1857. In another place Redman says : " . . . North Weir Point is now opposite Hollesley. It was, half a century back, more than a mile farther south, so that in three centuries the shingle appears to have travelled south-westwards about five miles . . . ."

Redman's paper was read on January 26th, 1864, and may have been written a year or two previously. Fifty years back from that date brings us to 1810 or thereabouts. The 1805 map, however, shews that the end of the spit was then almost due east of Hollesley and certainly does not indicate that it was a mile farther south.

Again, it does not seem safe to accept the accuracy of the Henry VIII. map. We have assumed 1530 as the approximate date of this map. If, then, about that time the shingle had reached more or less the position of the present Stonyditch Point, and if we assume the relative accuracy of the next, the "Elizabethan," map of c. 1590, we must also accept the fact that the bar grew in this short period about two miles, or an annual addition of between 55 and 60 yards. But Redman almost certainly did not see Norden's Chart of 1601. This chart is in very close agreement with the "Elizabethan" map, at least, in so far as the position of North Weir Point is concerned. Norden's Chart also agrees in this respect with Appleton's map. Accepting the accuracy of Norden's chart and the fact that the bar attained its maximum length about 1897, we have a growth of about $2\frac{1}{2}$ miles in 300 years, which indicates an average annual addition of just under 15 yards. Taking the growth of the bar in this period as a fairly sound estimate, and remembering also that this is the thinnest part of the bar, we can hardly assume that previous to 1601 it grew about four times as fast.

Finally, reverting back to our contention that Orford Castle was built about the time when the spit did not extend further south than Stonyditch Point, we have a period of about seven hundred years (1165-1897) in which the total growth amounted to nearly $5\frac{1}{2}$ miles, or an annual increase of about 13 yards. This figure is in quite good agreement with the 15

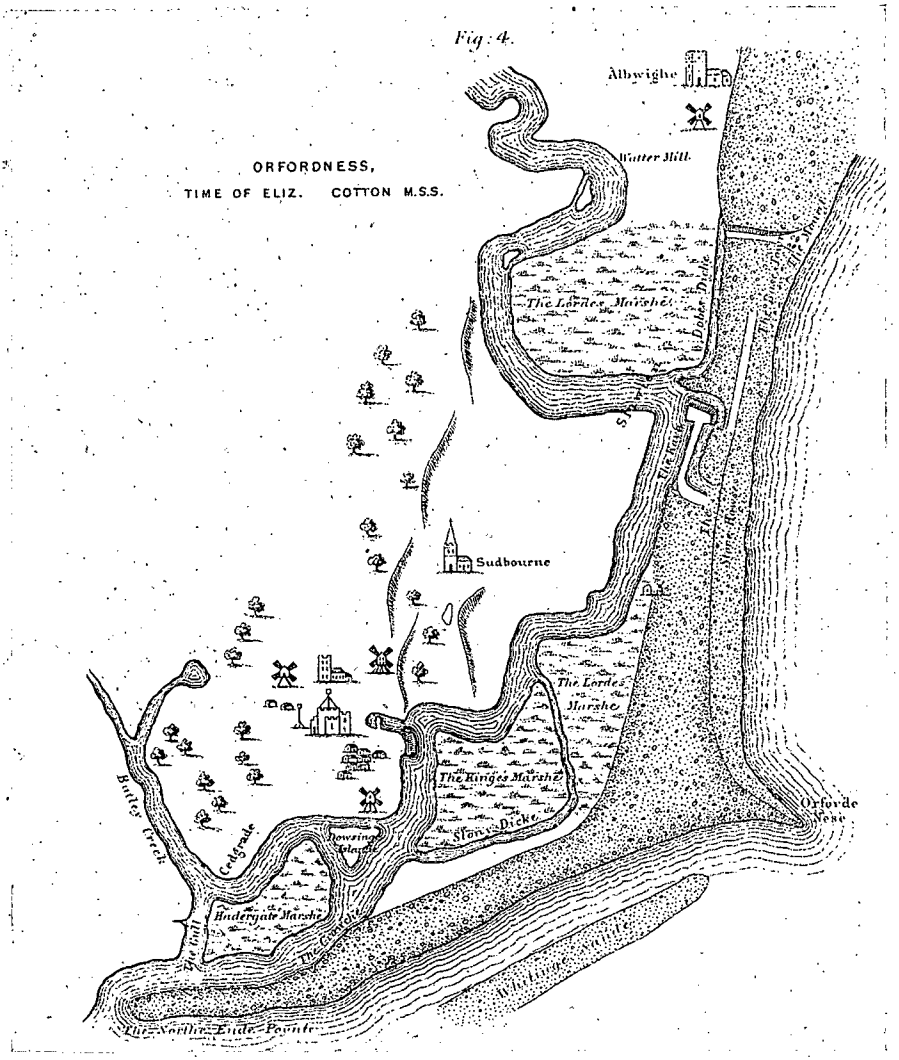



Fig. 4.

THE ELIZABETHAN MAP.

After the reproduction by J. B. Redman.

Mins. Proc. Inst. Civ. Eng. XXIII. 1863-4. Plate 2, Fig. 4.

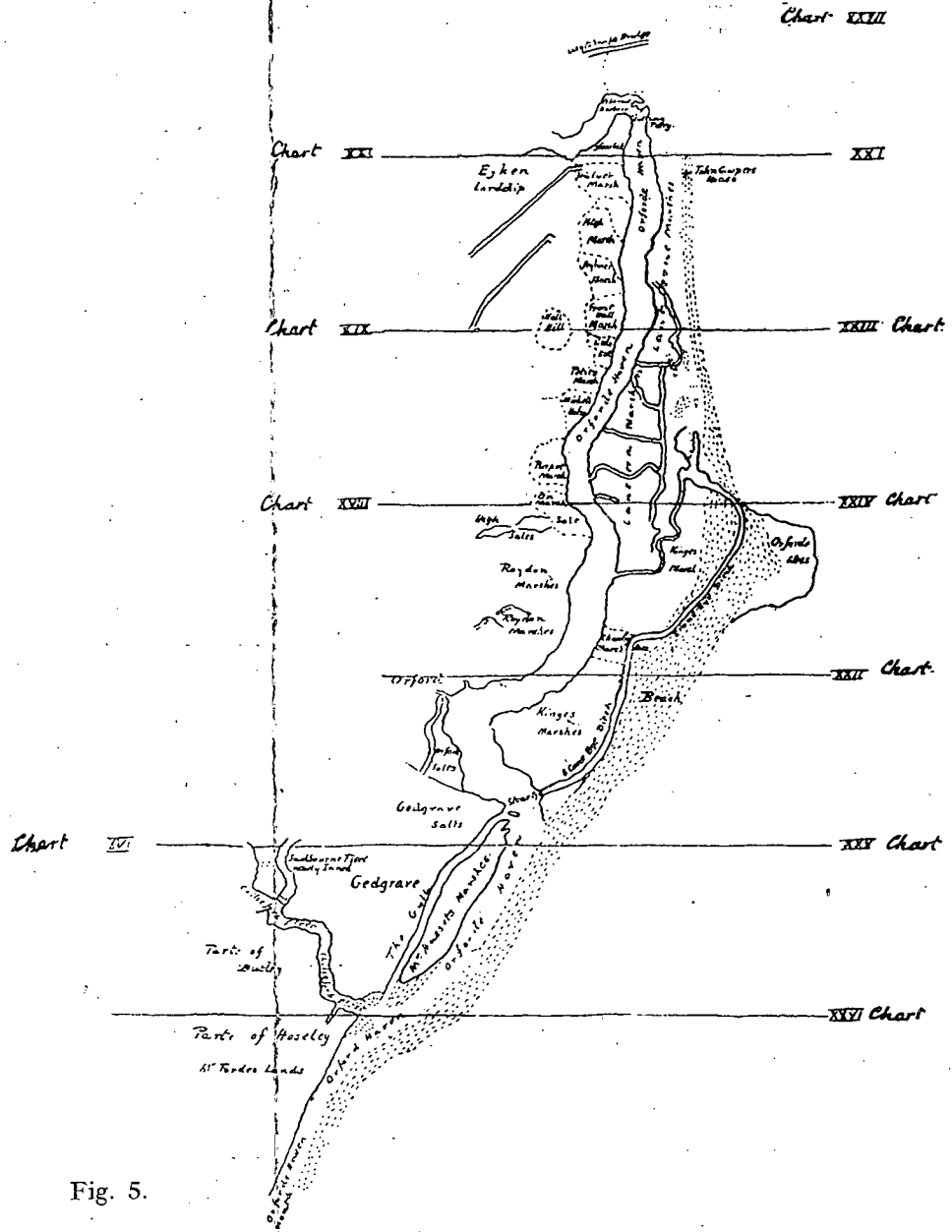



Fig. 5.

NORDEN'S CHART OF THE RIVER ORE, 1601.

From the reproduction in V. B. Redstone's *Memorials of Old Suffolk*, p. 230.

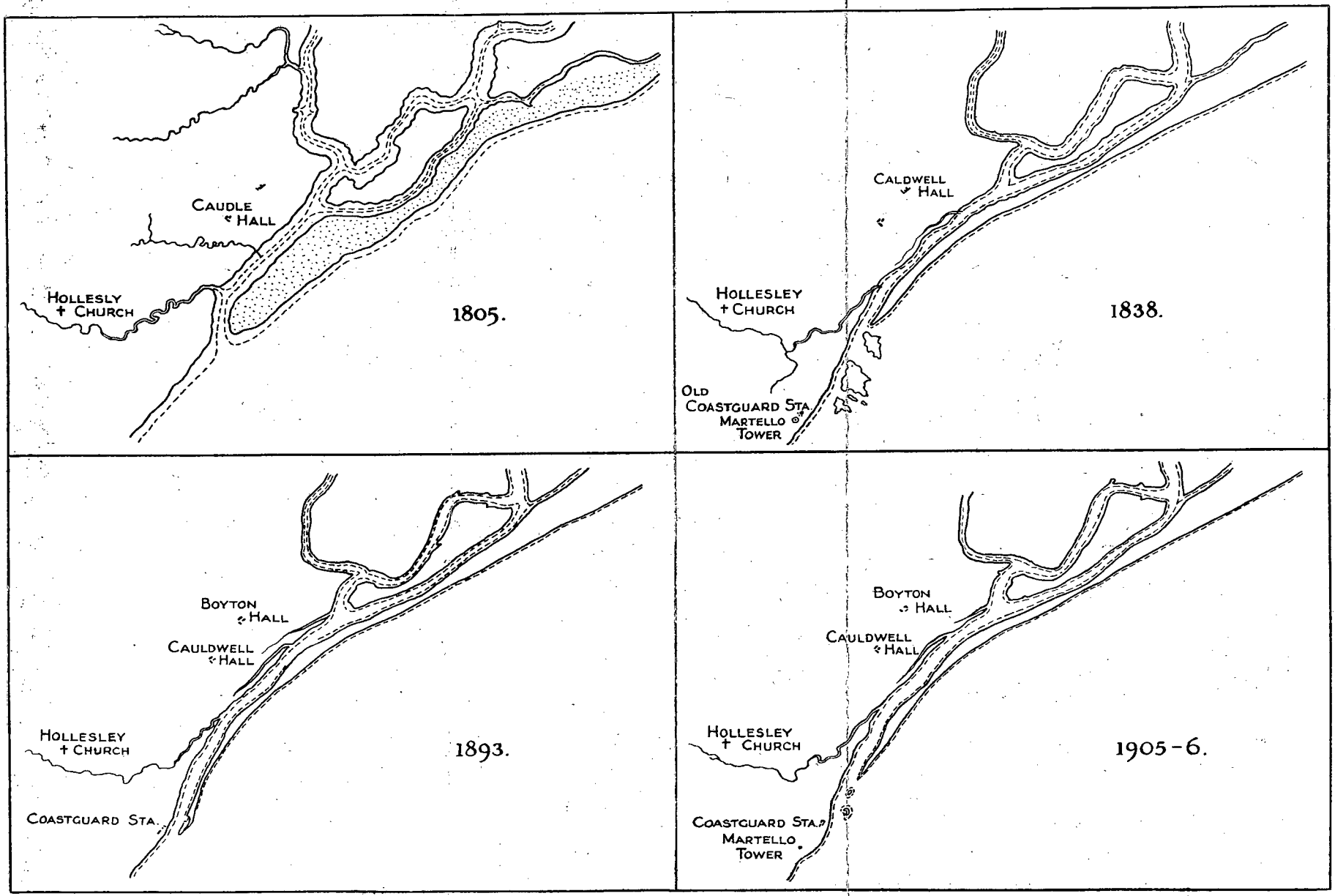



Fig. 6. The name 'Cauldwell Hall' is not always attached to the same buildings.

yards per annum since Norden's time. At the same time the argument also suggests that the Henry VIII. map really represents this part of the coast, at any rate, as it was in Henry II.'s time—the reign in which Orford Castle was built.

### THE STONE EYE: HAVERGATE ISLAND AND THE GULLS.

The Stone Eye or the Stonyditch is the main drainage channel of the King's Marshes. It divides these marshes and the group of ridges marked C from the major part of the shingle bar. The ditch is not shewn on the Henry VIII. map. On the "Elizabethan" map it appears as a watercourse encircling the King's Marshes. Without doubt its course has varied greatly, partly as a result of artificial changes made in connection with drainage schemes for the marshes. On Norden's chart it forms part of a rather complex system of waterways. A point of some interest here is that it gives an index of the amount of retreat of Sudbourne Beach. The course of its northern part as shewn on Norden's map no longer exists. Now, in the "C" ridges there is a triangular pond which seems to coincide fairly well with part of the enclosed course shewn on Norden's map. The beach, in its retreat, has transgressed this loop, and only the shingle of the present main beach ridge separates the ditch from the sea, thus giving a very "blunt" head to the Stonyditch. This point is borne out by later maps of the seventeenth and eighteenth centuries.

Havergate Island and the two channels known as the Gull and Lower Gull must be considered together. South of Orford town the map shews a rather abnormal system of waterways. The main course of the Ore runs by way of the Narrows. The two Gulls, at first sight, suggest that Havergate Island once formed part of the marshlands on the western bank of the

river, and that the Gulls themselves were formed in a rather unusual way. So much is suggested by the map. Redstone holds the same opinion, but is able to support it with historical evidence. The following lines, taken from "Memorials of Old Suffolk," will explain the origin of the present channels.

"In time, as the tongue of Shingle, and consequently the mouth of Orford Haven, gradually extended southward, the waters of the Ore found themselves pent up in a narrow channel between Mr. Hasset's Marshes (i.e., Havergate Is: see Norden's Chart) and the shingle bank. The force of the stream broke away at the southern extremity of the flat lying west of the Marshes, and so formed an island and Channel known as the Upper Gull. The same phenomenon was repeated, owing to the final junction of the three collections of shingle at the southern extremity of the Island and the opposite points of land, and the mouth of the Chillesford Fleet or Butley River. The pent up waters of Butley River forced a passage at Hollesley Fleet, destroying the ancient Ky haven and forming channels continuous with the Gull, and known as Abraham's Bosom and the Lower Gull. The portion of Hollesley lands cut off by this action of the Butley River became attached to Mr. Hasset's Marshes by a strip of shingle, the whole now forms Havergate Island."

In short, the northern portion of Havergate Island was once part of Gedgrave Marshes; the southern part of Hollesley Marshes. The former mouth of the Butley River lay across the narrow part of Havergate Island. A comparison of the present map and Norden's chart will make this explanation clear.

Havergate Island is now marshland which has been "inned." Occasionally it is flooded. These floods

are usually connected with high spring tides and south-east winds. The water is then ponded back in the river and rises above the normal limits of high spring tides.

## Aldeburgh and Neighbourhood.

Before giving an account of the evolution of the bar, a short description of the conditions prevailing at Aldeburgh and neighbourhood may be of interest. Many records exist to shew that the beach at Aldeburgh was formerly much wider than now. Defoe says: "Aldeburgh has two streets each a mile long, but its breadth, which was more considerable formerly, is not proportionable, and the sea has of late years swallowed up one whole street." Maps of Elizabeth's time bear witness to this. The lower part of the town is built mainly on shingle, which also extends up to the hill at the back of the town. A boring near the Moot Hall gave the following section: At the top 4 feet of made-up ground, then 12 feet of shingle which became more sandy downwards: below this 2 feet of Coralline Crag, increasing in thickness landwards, and below the Crag, London Clay. A similar section in the hill at the back of the town shewed:—

| | | |
|---|---|---|
| Drift | .. .. | 4 feet |
| Chillesford Clay | .. | 8–20 feet |
| Red Crag .. | .. | 10 feet |
| Coralline Crag | .. | |

The hill thus marks the line of ancient cliffs. The beach in front probably continued to grow well into historic times and may have reached a maximum in the sixteenth century. After that, however, erosion seems to have removed a good deal of the beach as Defoe noted. It may be remarked that the site of Crabbe's house is now under the waves. Undoubtedly there were also many minor oscillations whose effects cannot now be seen.

About two miles to the north of Aldeburgh is Thorpeness, a small sand and shingle headland. Its northern side is suffering some erosion, and this is balanced by some accretion on its southern face. In 1923 there were four or five well marked, but small shingle ridges which extended up to Aldeburgh, and were, in fact, the direct continuation of the Sudbourne Beach ridge. The accreting area does not extend beyond the Coast Guard Station at Aldeburgh. After passing this point we come again into a stretch of coast where erosion is dominant. The case is somewhat similar to Covehithe Ness to the north of Southwold, and also to the north and south sides of Orford Ness itself.

Some valuable information relating to erosion at Aldeburgh was furnished by Mr. Gordon, the Borough Surveyor. He writes " that the present storm full (i.e., main beach ridge) is gradually being pushed back on to the river Alde by each successive storm, and there is no ground high enough behind it and south of the Old Mill House (this house stands farthest south in Aldeburgh) to return the shingle seaward." Of Slaughden Mr. Gordon says " . . . In 1896 there were eight houses occupied . . . with a population of about thirty people and there were also several warehouses and trades carried on . . . and the " Three Mariners " Inn was occupied. There is now not a single house occupied in Slaughden. The southern portion of Crag Path (i.e., the path made up of Coralline Crag which runs along the front at Aldeburgh) has been repeatedly washed away, and the dwarf retaining wall on the eastern side of the path has been rebuilt four times in twenty years. In 1895 serious damage was caused at Slaughden by the storm of that year, the road from near the old Wind Mill (at the south end of Aldeburgh) to beyond the " Three Mariners " Inn was covered with shingle to a considerable depth (10-ft. in places). The road was cleared in 1896, but was

again covered in 1897 and 1899. The Corporation then decided to make a new road at a higher level, and this road is now being washed away and the shingle is being gradually pushed back on to the saltings."

Slaughden may be taken as the beginning of the bar proper. From here the shingle runs southwards for about eleven miles. Between the shingle and the high ground to the west of the Alde are extensive marshes. The high ground marks the line of the former cliffs, and can be followed on the map by the 50-ft. contour line. This high ground is composed mainly of the Coralline and Red Crags topped by glacial deposits. The two following sections taken from the Geological Survey Memoir of the area shew the disposition of the strata beneath the marshes.

1. Well Section (Lantern Marshes).

| | | Thickness | Depth |
|---|---|---|---|
| Alluvium | Ooze | 24 feet | 24 feet |
| Red Crag | White sand and shell | 7 ,, | 31 ,, |
| London Clay | | 129¼ ,, | |
| Reading Beds | | | 160¼ ,, |
| Chalk | | | 280 ,, |

2. Well Section (Lord Rendlesham's Marshes).

| | | Thickness | Depth |
|---|---|---|---|
| Alluvium | Soft Clay | 30 feet | 30 feet |
| Red Crag | White Clay | 2 ,, | 32 ,, |
| London Clay | | | 36 ,, |
| Reading Beds | | | 152 ,, |

## The Evolution of the Bar.

The bar is a structure built up by the combined work of waves and the longshore drift. It has been pointed out already that the longshore drift is to the south along the Suffolk Shore, and hence it is, to all intents and

purposes, working parallel with the spit. Further, the longshore drift is working with wavse coming in from the open sea from the quarter between north and east. It is to be noted that this is the direction in which lies the greatest fetch of open water relative to the spit. Waves from this quadrant would naturally set up southward directed beach drifting. It is almost impossible to separate the effects of waves from those of the longshore drift. All that can be said is that analogy with comparable features on the north Norfolk shore suggests that waves are the more important factor. It may be remarked in passing that Marsh has seen sand drifting northwards with the ebb and shingle thrown southward by the waves at the Ness. (Proc. Geol. Assoc., 36, 1925, 434).

Orford bar originated as a small and simple shingle spit which gradually formed across the old mouth of the Alde at Slaughden. We cannot say when this spit first began to form, but we need have no hesitation in assuming that its distal end would recurve landwards and that it grew forward—southwards—as a series of such land-directed hooks. If reference is made to the map it will be seen that as the spit continued its southward growth, it progressed farther and farther from the mainland. [The land of the time may be taken as coinciding with the 50-ft. contour.] But during all this time the waves were gradually driving the spit as a whole landwards. The inter-action of these processes can be made clearer with the aid of a diagram. (Fig. 7).

Let the continuous line A'.A. represent the spit at an early stage of its growth. The recurved ridge lettered A corresponds with the *group* of ridges marked A on the map. As time went by the spit lengthened and at the same time the waves pushed it landwards. This stage is shewn by the line of dashes, B'.B., B

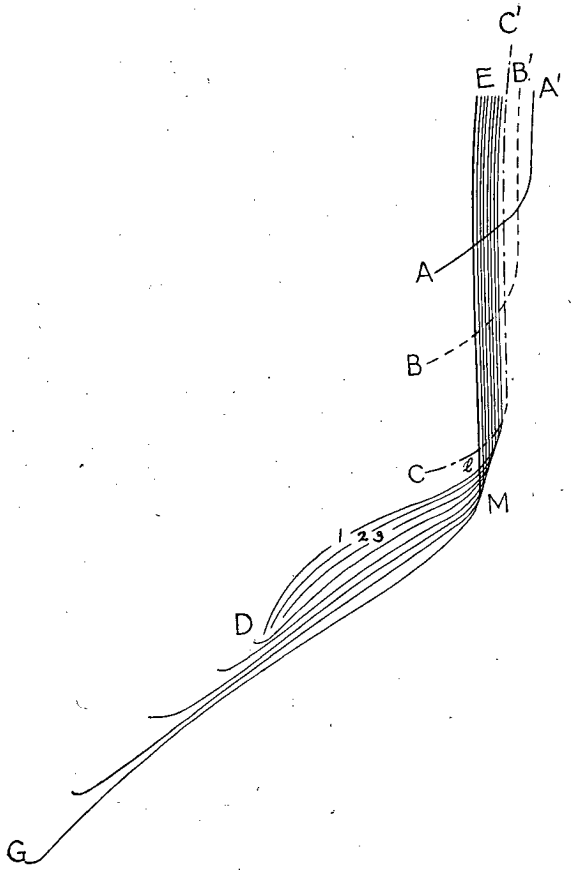



Fig. 7.

DIAGRAM TO EXPLAIN THE EVOLUTION OF ORFORD NESS.

No attempt is made to show the correct number or the exact orientation of the individual ridges. There are more than forty just south of the Lighthouse.

representing the *group* of ridges B on the map. Repetition of this process gradually led to the formation shewn by the dash-dot line C′.C. C corresponds to the group of ridges just to the north of the upper part of the Stonyditch. The next ridges to be formed are those labelled 1, 2, 3. These represent the ridges running behind the lighthouse. When these ridges were being formed there was a bay-form outline as shewn by the line $l^1$D. But gradually as newer bars were formed in front of those marked 1, 2, 3, the bay-like outline sooner or later disappeared and the present form, shewn by the line E.M.G., evolved.

Near the point D on the map (and Fig. 7) the older bars 1, 2, 3 are partly overlapped by the newer bars. As seen from the balcony of the Lighthouse this overlapping appears as a very oblique truncation. Further, it will be noticed that many bars end here ; these are the ends near Stonyditch Point already mentioned.

The spit nevertheless continued to grow southwards, and, as can be seen from the map, it also decreased greatly in width. The extreme end of this thin portion was obviously very unstable, and was made to recurve landwards by wave action. But at the same time there were constant supplies of new material travelling down the spit from the north. This material either directly or indirectly lengthened the spit. The combined effects, then, of the waves and the constant renewal of material were responsible for the long, narrow part of the spit, with its excellent recurved ends, south of Stonyditch Point.

" Whilst the spit may owe its general formation to wave action and to the longshore current, certain modifications were probably brought about by other factors. The Ness point (i.e. the lighthouse point) is at the place where material drifting alongshore from

the north should leave the coast and try to continue its course in a straight line.* In calm weather some material may merely "creep" round the point, but in stormy weather the greater force of the waves and other factors should carry material farther south. Such material would later be driven shorewards and built up by the waves into ridges of considerable length. That such is the nature, in part, of the ridges south of the lighthouse is corroborated by observations made on two visits to North Weir Point at the end of March and early in April, 1923. In this period, not characterized by any bad weather, a new ridge had formed. It was about half a mile long and merged northward into the previous main beach ridge. It appeared to be due quite definitely to the constructive action of waves acting along its entire length rather than to simple longitudinal accretion.

"The effect of winds on the profile of the beach is important. As elsewhere on the East Coast, the prevalent winds are from a point between south and west; the dominant winds from north-north-east and north-east. Hence, during a period of normal winds the beach "makes," but suffers very considerable erosion during strong north-easterly winds.† To some extent the change in the trend of the beach which takes place at the Ness causes the southern part of the beach to have rather more protection from north-east winds. However, toward North Weir Point the trend of the spit is again more nearly north and south and so this part is exposed to north-east winds. Furthermore the spit is here very thin, and often, as in 1897, great masses are cut off from the spit and piled up on the marshes at Shingle Street."‡

At Shingle Street there is a great mass of shingle,

*The orientation of the Whiting Bank strengthens this argument.
†This erosion is very marked between Aldeburgh and Orford Lighthouse.
‡These two paragraphs are taken *in toto* from the Geo. Jnl., Jan., 1927.

much of which is stabilized. The great quantities which were cut off from the spit in 1897 were thrown on to that already existing at Shingle Street in such a way as to form a deep lagoon which was still there in 1923. South of Shingle Street there is an unbroken line of shingle in front of the low-lying marshlands and Bawdsey Cliff. This shingle, as elsewhere in Suffolk, is moving southwards. Across the Deben estuary is a small, but very variable, bar. Shingle reappears south of the estuary and runs on past Felixstowe and collects in the huge expanse, known as Landguard Point, at the mouth of the Orwell. This point, which has been well described by Redman in the paper already quoted, shews the typical features of ridges and swales, many of them shewing beautiful recurved forms.

## Summary of Conclusions.

1. Orford Ness is a foreland of marked cuspate pattern and is composed almost entirely of shingle; some sand and mud are occasionally exposed at very low tides. The mud is called locally "Blue Slipper."

2. It owes its formation to the combined work of waves and longshore drift. Both of these agents are here working in the same direction, and it is not easy to differentiate between them.

3. The district is one of soft rocks and forms a portion of the submerged East Anglian Coast.

4. Quite 99% of the shingle is flint. Originally the flint came from the chalk, but a great deal is now contained in the numerous beds of glacial origin which occur in and near the cliffs of East Anglia. It is, therefore, probably unnecessary to assume a distant origin for most of the shingle. It should also be borne in mind that some of it may be derived from glacial

deposits on the floor of the North Sea. Fragments of other rocks do occur, chiefly from the hard igneous rocks of Scotland and Scandinavia.

5. The evolution of the beach may be followed by studying the run of the ridges or fulls. The relative age of the fulls may be obtained from places where one set is truncated by another set. These truncations are comparable with unconformities in the geological sequence.

6. A study of maps and documents suggests an average annual growth of nearly 14 yards for the 700 years ending 1897.

7. The marshes within the shingle have grown up under its protection; there has also been much artificial land-reclamation.

8. The bar is in many respects similar to Dungeness in England. Cape Carnaveral in the United States and the Darss in Germany are similar formations abroad.

NOTE.—The map shews the spit as it was in 1908. In 1923 North Weir Point was practically due east of the Colonial College.