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THE NATURAL HISTORY OF SLAPTON LEY NATURE RESERVE

IX: THE MORPHOLOGY AND HISTORY OF THE LAKE BASINS

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Abstract

The shore of Start Bay is fringed by a shingle bank some 9 km long that has dammed the lower reaches of the valleys that drain to the coast. The longest unbroken section is a 3·5 km barrier beach known as Slapton Sands that impounds two lakes—the Higher and Lower Leys. These are separated by a rock spur and although drainage water is diverted from one to the other they are distinctly different in their ecology and water chemistry. Beneath the Lower Ley submerged peats lie on estuarine clays and C-14 dates indicate that the estuarine phase came to an end with increased coastal stability approximately 3,000 years B.P. The two lakes are approximately 1,000 years old and becoming increasingly eutrophic: the more recent lake sediments have a high diatom content.

Introduction

Slapton Ley Nature Reserve is based upon two former lagoons impounded by a barrier 3·5 km long and together they form half of the total area administered by the Field Centre. The Lower Ley is an open lake with a narrow reed fringe while the Higher Ley is almost completely covered by vegetation—a fringing reed swamp surrounding floating rafts of peat with carr. This vegetation mat is bisected by a man-made channel that carries water from the river Gara southwards through Slapton Bridge to the Lower Ley for most of the year but in hot summer weather the flow may be halted or even reversed.

The Early History of the Coastline

The relief of South Devon is dominated by a series of platforms, the product of past periods of erosion, which are well preserved as benches and summit levels. The most extensive is at 137 m O.D. forming the surface of the Start-Bolt platform and a series of spurs at Merrifield, north of Slapton. A second surface at 115 m O.D. notches the edge of the higher one at East Prawle and forms the summits of the ridges in the Kingsbridge corridor (Fig. 1). They are of early Pleistocene age and are bounded by a cliffline formed during the Ipswichian (last) interglacial period (Orme 1960 and 1964), some 100000 years ago. There may have been more than one stillstand in the Ipswichian as, at Mattiscombe there is a distinct platform at 4 m O.D. separated from one at 7 m O.D. by a low cliff. Offshore, the floor of Start Bay is a rock shelf 10-20 m below O.D. and up to 3 km wide.

The preservation and extent of raised beaches and platforms depends on aspect, exposure and the relative resistance of the rocks to marine erosion. The main features of the coastline were cut by the 7 m sea and much of the coastline of Devon and Cornwall is flanked by relics of a platform at this height. In some places the 7 m platform has been replaced by one at 4 m and in others both platforms have been eliminated and the cliff re-trimmed by lower sea levels.

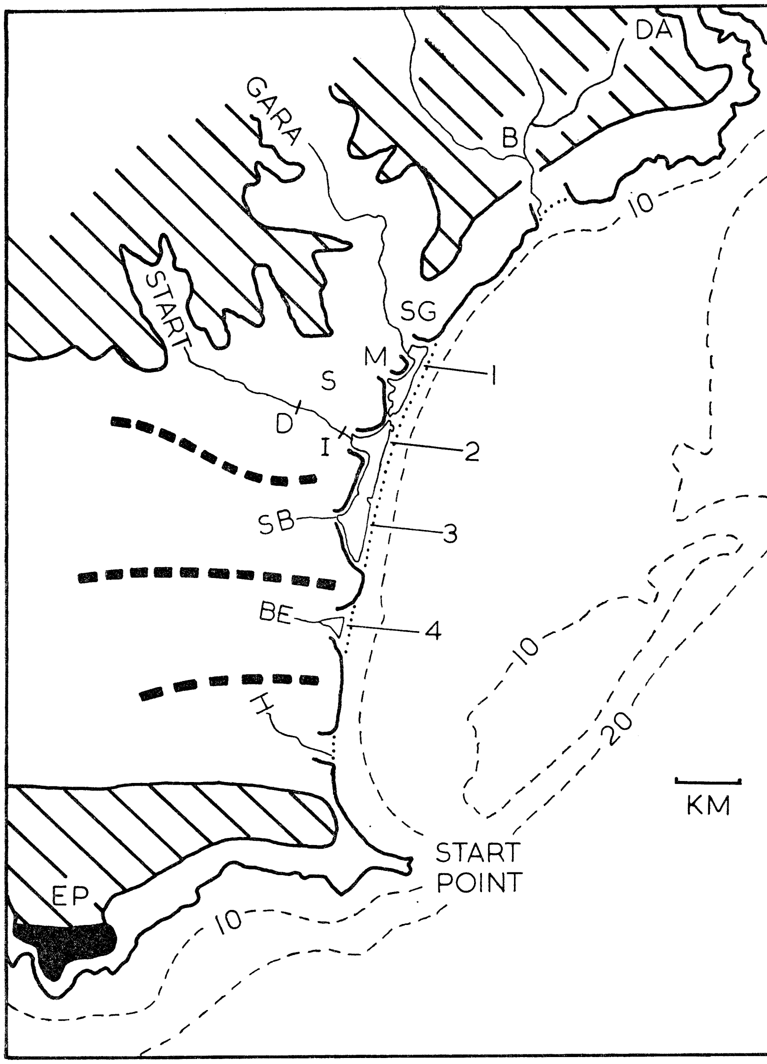

FIG. 1.

THE PHYSICAL GEOGRAPHY OF START BAY

KEY

////// — 137 m erosion surface.
▬ ▬ ▬ — crest of ridges at 115 m.
█ — 115 m bench at East Prawle.
▬▬▬ — Ipswichian coastline.
. . . . . — barrier beaches.
— — — — — submarine contours in metres.
1, 2, 3, 4—major bore holes (5 inch dia.).

ABBREVIATIONS: EP—East Prawle, DA—Dartmouth, BE—Beesands, B—Blackpool, H—Hallsands. M—Middlegrounds, SB—Stokeley Barton, SG—Strete Gate, S—Slapton, D—Deer Bridge, I—Ireland Bridge.

Between Hallsands and Dartmouth no relics of the 7 m platform survive and the 4 m platform is found only in sheltered sites behind the leys having been entirely destroyed on the headlands that are subject to active, present-day erosion. Thus, in exposed sites or on very soft rocks only the contemporary wave-cut platform exists, while on the hard quartz-mica schists of the Start a staircase of platforms suggests that each sea level did not last long enough for the complete destruction of the platform above it. Where it does occur, the 4 m platform is well preserved and has on it extensive deposits of iron-stained beach gravel and sand. The two raised platforms and the gravels are being exhumed from beneath a thick cover of head (Mottershead 1971) and, as this probably formed during the Devensian (last) glaciation, all must be at least as old as the preceeding Ipswichian high sea level phase.

The 4 m and — 10 m platforms are the most significant in this account as the 4 m platform forms the inner shore of Slapton Ley and the —10 m platform the surface on which the post-glacial estuarine and barrier sediments rest.

Post Glacial Changes

The decay of the Pleistocene ice sheets produced the world wide change in sea level known as the Flandrian transgression, mostly during the early part of the post-glacial period. The curves shown in Fig. 2 suggest that sea level rose rapidly until 5–6,000 B.P. (years Before Present). The main effect was to produce the characteristic drowned coastline of the British Isles and estuaries formed in the lower reaches of valleys such as those of the South Devon coast. This submergence still continues very slowly and Devon is sinking, relative to sea-level, at 1–2 mm per year.

Since the floor of Start Bay is a rock shelf 10–20 m below the modern sea level we can deduce from the curve in Fig. 2 that most of the area was flooded between 8,000 and 5,000 B.P.—a rate of coastal encroachment of 3 km in 3,000 years—and prototype barriers of the Slapton type existed during this period in what is now the offshore zone (Hails and I. O. S. Staff, 1975). However, the rate of onshore movement was so fast that any barrier would have been short-lived and unstable and it is unlikely that fresh water lakes with peat would develop behind any of them. Hails suggests that salt marsh conditions were usual and, despite an extensive programme of bore-holes and bottom sampling in the offshore zone, his team found only one site with fresh water peats.

After 5,000 B.P. the rate at which the shore line was migrating slowed down and the shingle banks became more stable forming barrier beaches that now seal off the drowned valleys. The situation is complicated by the fact that the present sea level is close to the high point reached during the Ipswichian interglacial period and the shingle is banked up against the old Ipswichian coastline. This feature is very much degraded and where streams have cut through it the lakes of Hallsands, Beesands, Slapton and Blackpool developed—each being the flooded lower reach of a valley dammed by shingle.

The earliest carbon-14 date from one of these lakes is from Beesands where a bore hole through the shingle ridge penetrated a thin, fresh water Phragmites peat at —4·5 m O.D. with a date of 4,767 ± 45 B.P. Peat indicates the presence of a closed lake, although landward beach movement continued for some time afterwards as the inner margin of the shingle is rather more than 100 m landwards of the bore hole. Slapton Ley continued to be a tidal lagoon for some time after this early fresh water phase at Beesands as the early peats do not appear until 2,889 ± 50 B.P. and closely follow marine sediments with *Hydrobia*, *Ostrea*, *Abra*, etc. These peats are banked up against the landward face of the shingle barrier. All the evidence suggests that the shingle barriers have been stable since then: later marine deposits on the

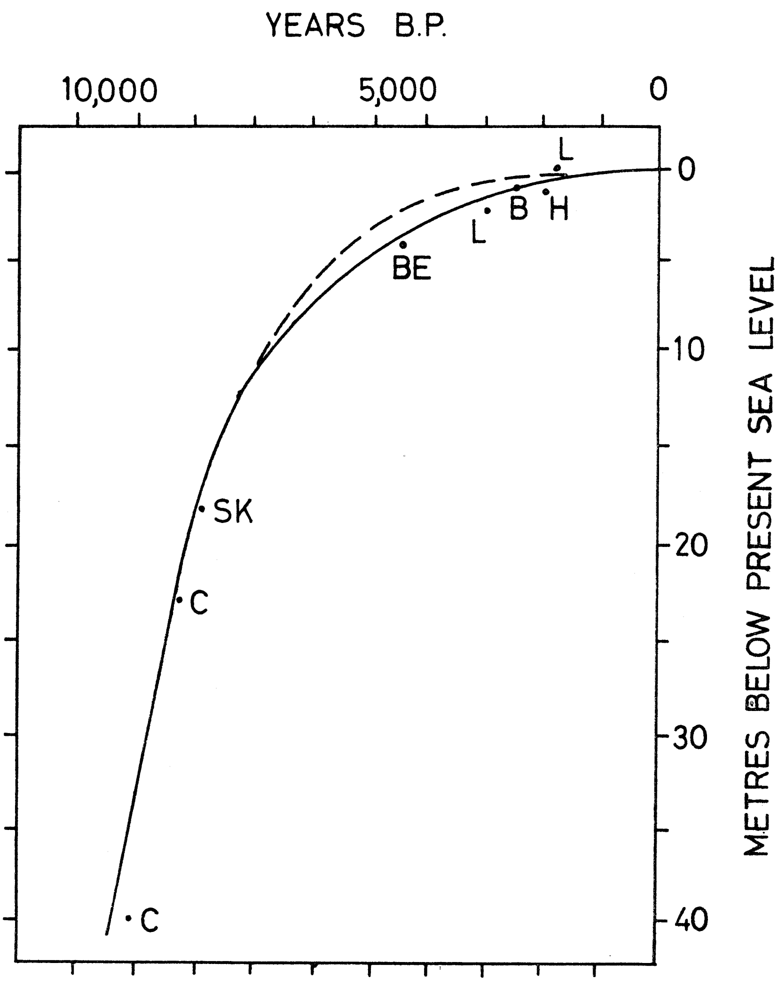

Fig. 2.

SEA LEVEL CURVES FOR THE LAST 10,000 YEARS

KEY

━━━ — Jelgersma 1966.

- - - - — Kidson and Heyworth 1973.

Abbreviations: B—Blackpool, BE—Beesands, C—approximate position of samples taken by Clarke (1970), H—Hallsands, L—Slapton Ley, SK—Skerries Bank core 70 (Hails and I.O.S. Staff 1975).

landward side are confined to occasional washover fans. The only changes during nearly 3,000 years have been the raising of the height of the crest and the steepening of the seaward face so that once the fresh-water lake was established marine incursions were rare and short-lived.

The Development of Slapton Sands

The sands are part of a barrier beach 9 km long from Blackpool to Hallsands, parallel to the old Ipswichian cliffline. For half the length the shingle is banked up against the cliffs but these are cut by six major valleys in each of which a lake has been impounded by the shingle barrier. The Blackpool and Hallsands lakes are filled completely with peat and silt and standing water is rare. The 3·5 km Slapton Sands is the longest uniform section of the barrier with only a small loss of height and width from north to south. At the bore hole by the central car park the crest is about 6 m O.D. and the exposed shingle 136 m from H.W.S. to the lake shore. Including the part that is submerged, the total width is 450 m and the crest rises 11 m above the marine mud on which it rests.

Barrier beaches are essentially an accumulation of the coarse material in the marine system concentrated in the high energy zone at the shoreline. They are usually at a high angle to the dominant wave direction and tend to extend the line of the coast, smoothing off irregularities in its long profile. Usually, there is a gradation in grain size from fine to coarse in the direction that is the resultant of the dominant wave direction. These points are beautifully illustrated by the barriers of Start Bay and Chesil Bank which face each other across Great West Bay as mirror images. In Start Bay the dominant fetch from the east produces a graded increase in pebble size from Blackpool southward to Hallsands while Chesil, dominated by the westerly fetch, shows a corresponding graded increase in size from Burton Bradstock eastward to Portland.

The observation in 1904 by the Devon geologist R. Hansford Worth that "the drift of beach material is nicely balanced" still applies. For instance, in January and February 1974, a prolonged spell of westerlies produced an exceptional northward drift and the southern end of each section of the beach suffered major shingle loss. The material so moved was piled up at the northern end of each section with a limited amount crossing the beach crest at Strete and Blackpool and so was lost from the active zone of the beach system. The height of the beach crest at Torcross fell by 8 m (Morey 1974), steel piles were undermined, and the village was threatened. Eighteen months later recovery has been limited and the beach has an uncharacteristic stepped profile in which the headlands have acted as giant groynes.

If we compare Slapton Sands with beaches at Chesil, Porlock or Newgale we find important similarities of form and origin. All consist of a ribbon of shingle spread across a stable substrate of mud or rock and contain a large proportion of non local material. Analyses of the lithological composition of the Start Bay shingle, both by pebble counts and weight, agree that the proportion of local rock types derived from the cliffs of Start Bay or from the River Dart catchment is never more than 30% (Mercer 1966). Most of it is small, well rounded, weathered flints and a variety of erratic igneous pebbles. The relative proportions are constant from one end of the beach to the other and there is little doubt that Start Bay is a closed system with no transport of material along the cliffs at either end. Fresh flints, often found along the coast west of Start Point but never in Start Bay itself, suggest that this source of supply has been cut off for some time. Attrition and lack of replenishment would account for the small size of the pebbles and suggests that the proportion of non-local material was formerly much greater than at present.

Steers (1946) suggested that Slapton Sands developed as a spit extending south from the mouth of the Gara—an idea that is supported by the gradation of pebble size. However, this implies a southward drift of material along the shore for which there is no evidence. In fact all the evidence suggests that the beach is slowly moving inland up the coastal slope, keeping pace with a progressively rising sea level.

Because of the relatively long time scale involved, the study of barriers has been largely confined to their stratigraphy and to models. From small-scale studies on

Russian reservoirs, Zenkovich has added to the pioneer work of Johnson (1919) by suggesting that such features are present on shorelines with a low gradient and a rising water level. The ideal situation exists over long sections of the world's coastlines where the Flandrian transgression has covered extensive erosion surfaces with shallow water. When the shoreline is advancing rapidly the barriers are sub-marine bars and any small barrier islands that develop will be ephemeral features backed by lagoons that are equally impermanent and tidal or brackish (hyposaline). This fits perfectly with the results obtained by I.O.S. staff in the course of their work offshore. A barrier becomes stable only when the rate of transgression slows almost to a halt and material continues to move forward onto it as the seaward face steepens and breaks surface as a series of islands that coalesce to form an unbroken ridge. This is then capped by a storm beach that grows to such a height that it is rarely crossed by waves. Only under such stable conditions will fresh water lakes develop on the landward side. Hence the comment by Hails (1975) that peats are rare in the offshore zone.

The curves shown in Fig. 2 suggest that the Flandrian transgression has slowed almost to a halt during the past 5,000 years, so that sea level has been relatively stable and the barrier has remained close to its present position. An additional factor that must be considered is that the barrier has reached the Ipswichian coastline and for much of its length is backed by cliffs. The headlands act as nodes controlling the longitudinal form of the barrier and with any further advance will break it into five separate beaches with a total length of only 50% of the present feature. This reduction in length will produce a corresponding increase in width as the headlands are exposed and shingle is shifted laterally to build up the remaining sections.

Profiles by Worth, Robinson and I.O.S. staff (1975) suggest that the beach profile varies little over a long period and Worth demonstrated that, when the volume of available material was reduced by dredging at Hallsands, "the beach took a great stride landwards". What happened was that the same profile was maintained and the appropriate reduction in length gained by moving farther up the valley. Since Start Bay is a closed system and material is not normally removed, the dimensions of Slapton Sands must be a function of the bulk of the material available, becoming wider as they are pushed landward into a progressively narrowing bay. A beach crest is rarely crossed by storm waves and so, as the barrier becomes wider, this will happen less often, until equilibrium is reached. The position of the barrier is then fixed as long as sea level remains stable.

Sedimentation in the Lake Basins

The first examination of the ley sediments was by Crabtree and Round (1967). They described a core 1·2 m long from Ireland Bay. Unfortunately its exact location is not known and so it cannot be exactly tied in with mine, but probably they took their sample from the edge of the delta sediments. The length of the core was limited by the performance of the Livingstone corer they used. The Hiller borer I used proved better able to penetrate the full range of sediments and the results obtained from the 180 holes are summarized in the following account.

The Sediments of the Lower Ley

The sediments of the lake basin differ sharply from those of the deltas that extend into it and the two types will be discussed separately. The Higher Ley has a different history and the form of the two lakes suggests that the connection between them has been made recently—probably by man.

The most complete and informative section is at the seaward end of Ireland Bay and a section along a transect line from the pill box to the beach is shown in Fig. 3. A similar succession can be found to the south and north of this section but overlain by a washover fan of beach gravel that thins out landwards. The extent of these gravel fans is shown in Fig. 5 and they are almost impossible to penetrate with a light, hand-operated borer. The typical section shows that the lake shore is a gently sloping platform of rock and slate gravel at the base of the degraded fossil cliff that runs from Torcross to Strete Gate. The upper edge of this platform is at 4 m O.D. and the lower edge is a submerged cliff that plunges to an unknown depth. The lake sediments pile up against this.

The lowest layers of the lake sediments are peats and detritus muds that rest upon estuarine sediments containing fossils such as *Hydrobia ventrosa* and *Abra tenuis*. The carbon-14 date for the lowest peats ($-1 \cdot 79$ m O.D.) is 2,889 $\pm$ 50 B.P. and for the upper part of the section ($-0 \cdot 19$ m O.D.) 1,813 $\pm$ 40 B.P. So a proto-ley existed behind a stable shingle barrier for a little over 1,000 years during which is supported a peat-forming vegetation that kept pace with a rising water level. This state of affairs was ended rather suddenly by an invasion by the sea which covered the peat with a layer of muddy sand containing pebbles and shell fragments. This marine band thickens seawards and is remarkably consistent over the whole of the Lower Ley. The curve in Fig. 2 tells us that modern sea level had been reached by the time that this layer was deposited and, as it is slightly below O.D., it can be the record only of a short period during which the barrier was breached and the sea invaded regularly. The position of the later washover fans makes it very difficult to find the exact site of the breach but it was certainly south of Ireland Bay and the present configuration of the barrier, taken together with historical evidence, suggests that a breach is likely to have occurred near Torcross during easterly gales.

Fresh water conditions were restored fairly quickly and the sand layer is overlain by reddish-brown clay muds derived from the lake catchment. These muds grade upwards into the black mud laden with diatoms that is now the charcteristic sediment. After this incursion by the sea, well developed large plant communities (macrophyte vegetation) seem to have been confined to the lake margins and deltas, with the washover fans at Torcross and Slapton Bridge, as the only evidence of later marine activity. The section shown in Fig. 3 lies between them. Their date is problematical: the fact that they are physically distinct suggests that they had separate origins and according to the wave pattern data given by Hails (1975) they should be the product of different wave systems. They certainly pre-date the deposition of the diatom muds and the building of the road (A379) along the crest of the barrier in 1856. Leland (1534) is quoted by Crabtree as saying that marine incursions had taken place and a medieval date would fit in very well with the stratigraphical evidence.

Figs. 4 and 5 describe the configuration and nature of the lake bottom which is remarkably level at about 2 m below the weir lip at Torcross. This depth is exceeded only in the centre of Ireland Bay ($2 \cdot 2$ m) and in a trench parallel to the America Road shore ($2 \cdot 5$ m). At 2 m the bottom is invariably covered with a black mud that, on analysis, consists largely of finely divided carbonaceous matter and the remnants of diatom cell walls. The shallower water has a bottom of firm, clean gravel

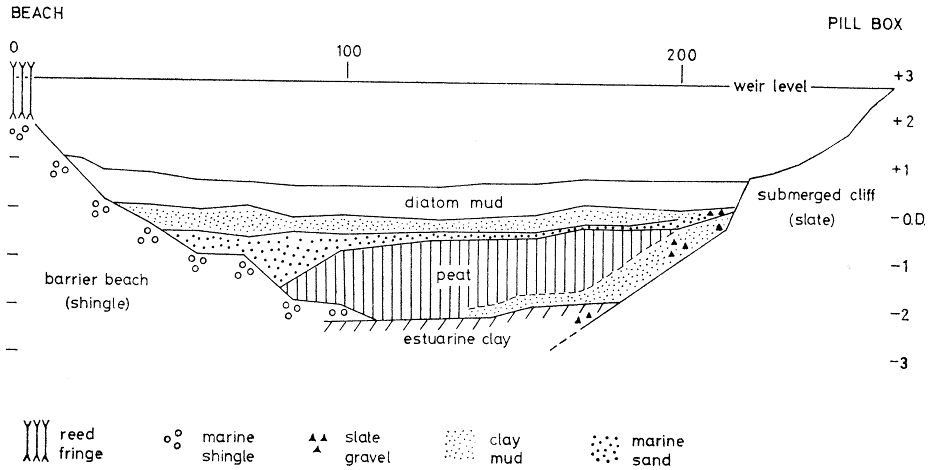

Fig. 3.

CROSS SECTION OF THE LOWER LEY FROM THE BEACH TO THE PILL BOX ON THE SOUTH GROUNDS SHORE (P-B on Fig. 5).

and the sediment distribution pattern is surprisingly like that of deep lakes with a thermocline. In a shallow lake of this type it is unlikely that a thermocline would persist for long and regular observations by Craig (pers. comm.) confirm this. However, even if no true deep cold layer (hypolimnion) exists, turbulence at the shore with either easterly or westerly winds may generate return currents along the bottom which sweep the shore, moving fine sediment to deeper water where it is less frequently disturbed. South of Ireland Bay, the Stokeley Barton ridge gives protection against the westerlies and dominant easterly winds could generate a stronger return current and thus explain the deep water trench close inshore. Some confirmation of this is in Fig. 6, which shows a section through what appears to be a bomb crater and is the only site in which the standard succession is seriously disturbed. The crater has been filled with diatom mud to the point at which the original contours of the bottom have been restored. This appears to confirm that dynamic processes within the lake produce a state of equilibrium in the distribution of the mobile sediment on the bottom.

The Delta Sediments

The typical lake sucession does not extend into the mouths of the two drowned valleys that form Ireland and Stokeley bays, where the sediments form a distinct delta type, largely of peat, and, although this is underlaid by estuarine muds at a depth of about —2 m O.D., the succession does not include the marine bands found elsewhere in the lake. It is hard to locate precisely the boundary between the two types but the Stokeley delta extends well out into the lake while in Ireland Bay delta sediments do not extend east of a line between Hartshorn plantation and the pill box. Fig. 7 shows a typical north-south section through the Ireland Bay delta.

The delta sediments are an extension of the lake peats; they are thicker and overlaid by clay muds and silts, in a way consistant with a rising water level. Physical and photographic evidence confirms that the reed beds (*Phragmites communis*) were formerly much more extensive in both bays. Reed swamp comes between the

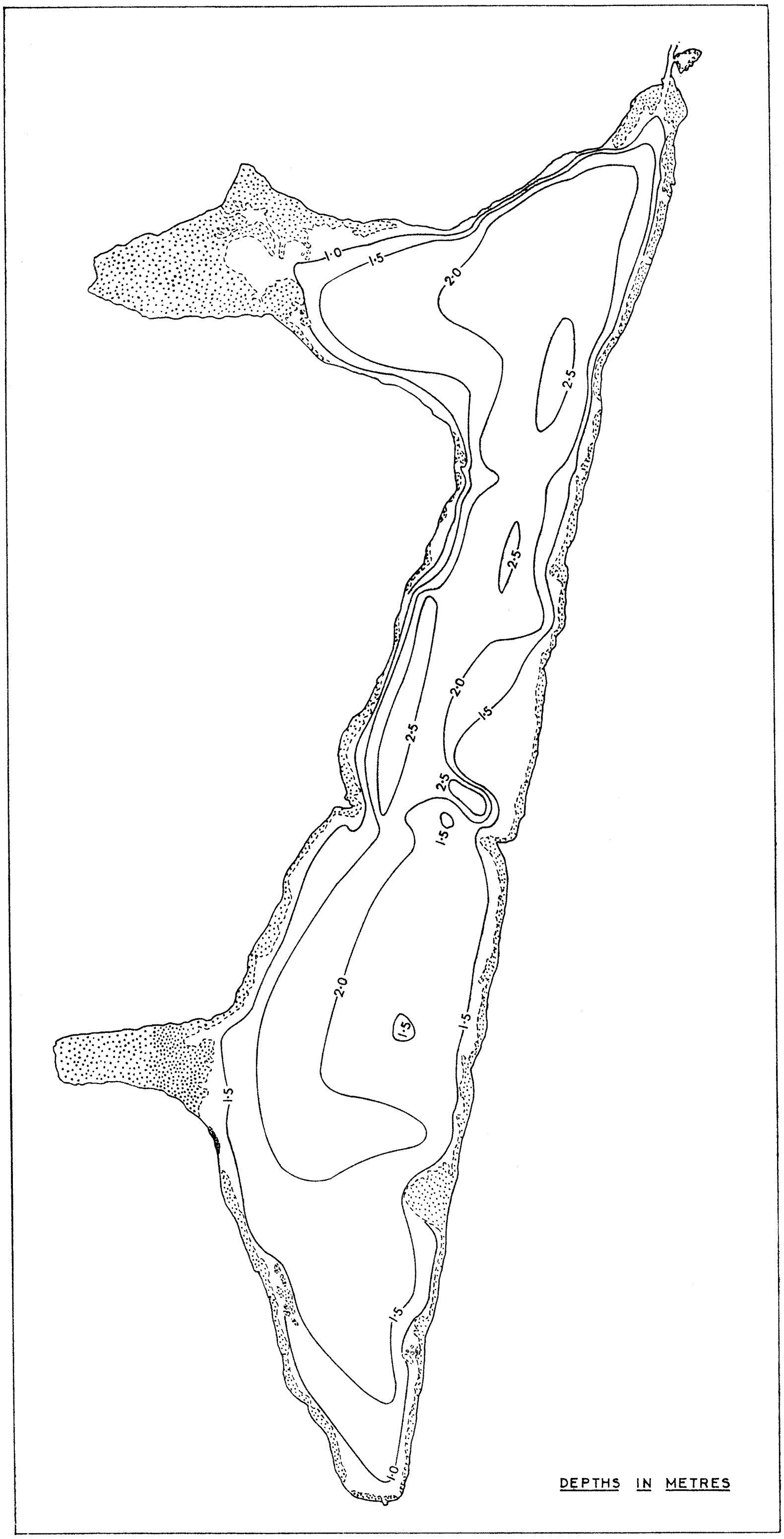

FIG. 4.

BATHYMETRIC MAP OF THE LOWER LEY.

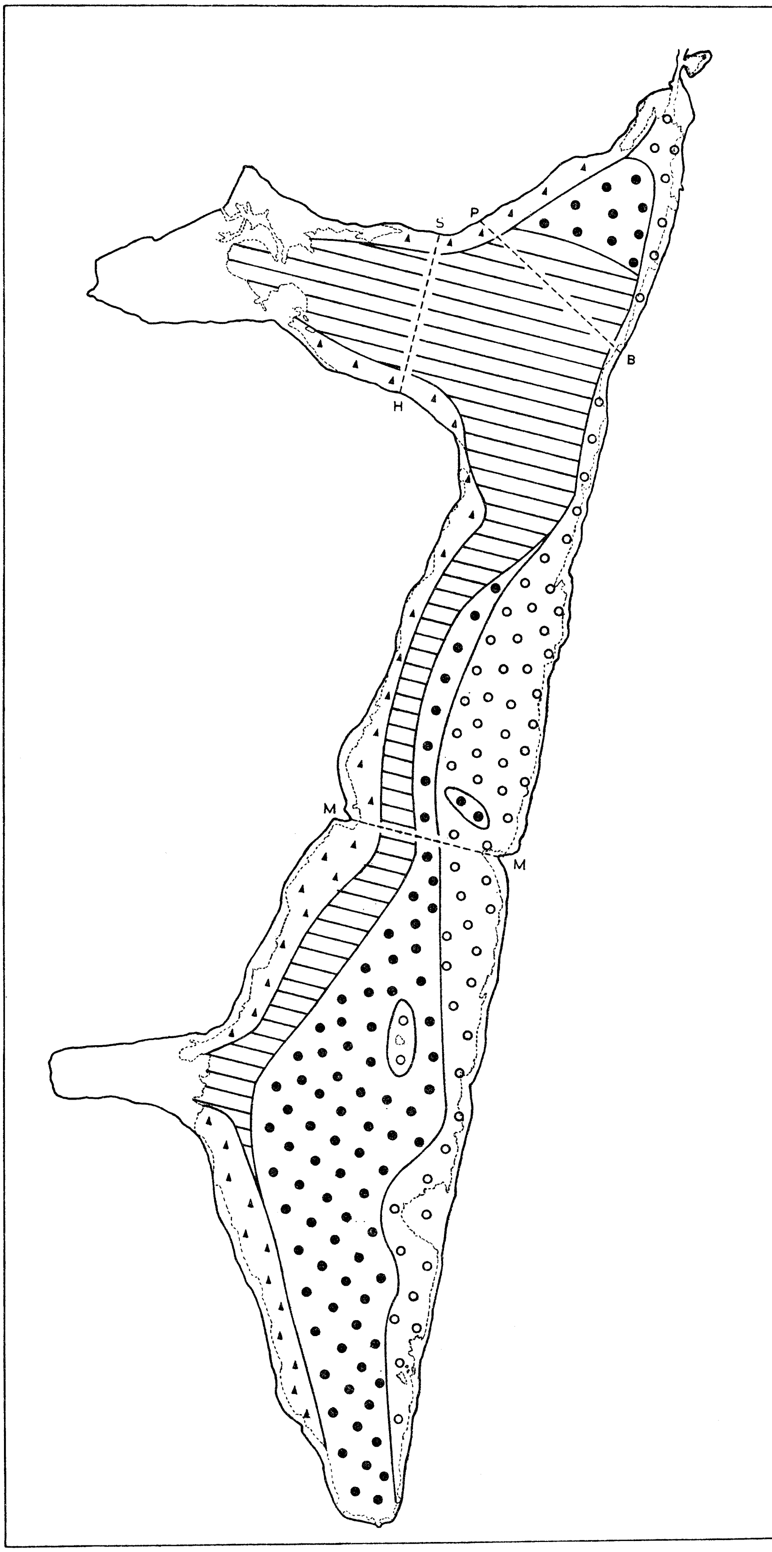

Fig. 5.

THE GEOLOGY OF THE LAKE FLOOR

The lake shore and shallow water areas are composed of slate gravel (triangular symbol) or marine beach gravel (circles). The rest of the lake bottom is covered with diatom mud that overlies peat (horizontal shading) or an extension of the washover fans of beach gravel (black dots). The lines of the sections in Figs. 3, 6 and 7 are shown by dotted lines.

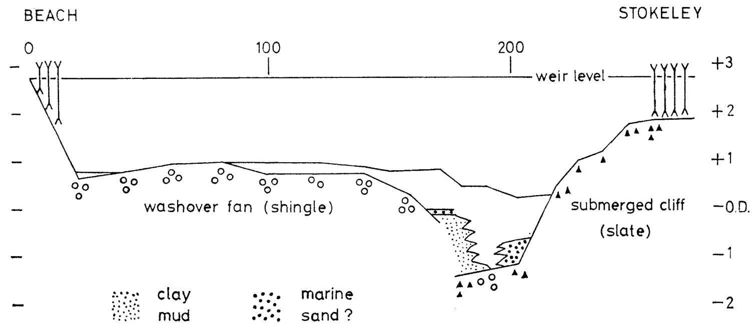

FIG. 6.

A SECTION THROUGH A BOMB CRATER (M-M on Fig. 5).

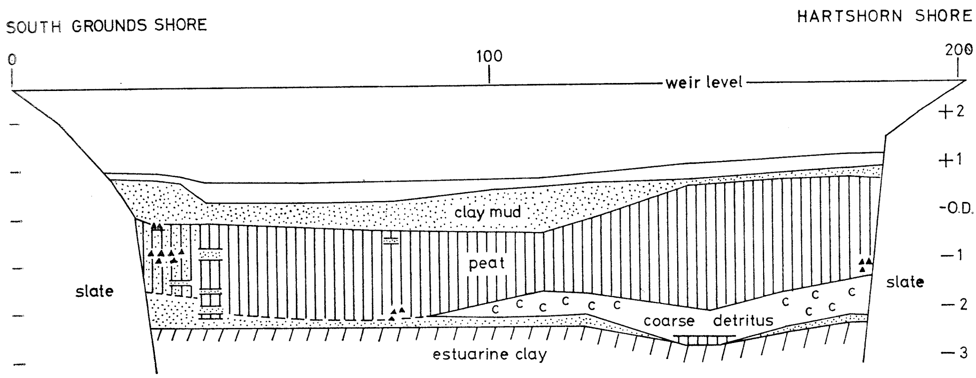

FIG. 7.

A SECTION ACROSS IRELAND BAY FROM SOUTH GROUNDS TO HARTSHORN (S-H on Fig. 5).

floating plant (water lily: *Nymphaea*) and carr (willow: *Salix*) stages in the succession from open water to dry land and gives way in deeper water to Reedmace (*Typha* spp.) and Bulrush (*Schoenoplectus lacustris*). Reed beds will tolerate flooding to a depth of 0·75–1·5 m, depending on the nutrient supply (Haslam 1968 and 1970). At Slapton the limit seems to be about 1·0 m and as the deltas are progressively flooded the reed front has retreated, with patches of Bulrush appearing on the outer fringes.

For many years the progressive flooding of the fields south of Slapton has been attributed to poor drainage. However, although the "drowning" of trees in hedge banks, the invasion of pasture by reed and the submergence of the small culverts at Ireland and Deer Bridge could be explained by subsidence, a rising water level is more likely.

The Higher Ley

The proximity of the two lakes means that they should have a similar history, but the Higher Ley is a much smaller feature bounded by rock promontaries at Broadstone Point and at Slapton Bridge. Because the Higher Ley is narrow, the inner face of the barrier extends right across it so that the inner edge of the shingle rests against the old cliff at the base of Middlegrounds fields. Thus the whole area of the basin is underlaid by beach gravel and it is difficult to drill through it to investigate the nature of the material below. Perhaps the most interesting point to emerge is that the Higher Ley has for long been a closed system. The vegetation cover is almost complete and much of it is on rafts floating on about 1 m of water and moving in response to changes in wind and water level. These rafts support a rather unusual plant community, dominated by Bracken (*Pteridium*), Bramble (*Rubus fruticosus*), Ivy (*Hedera*) and Broad Buckler Ferm (*Dryopteris dilatata*). Characteristic of a much drier environment, these plants are on floating rafts of peat 0·3 —1·0 m thick with a water table only a few centimetres below the surface. The most probable explanation is that they represent a relict flora developed under drier conditions, as part of a normal succession, and that with a rising water level the peat has floated clear of the firm, clay substrate and is slowly breaking up.

The location of the rafts is shown in Fig. 8; they occupy the central area of the Higher Ley separated from the shore by a fringe of reed growing in shallower water, rather sparse where growing on old pasture while healthy, dense reed covers the whole of the lower Gara valley. This central area seems to have been the original extent of the Higher Ley which was fed only by the small stream at Little Marsh and bisected by a narrow channel cut by the reed cutters.

Man-made Changes

In contrast to a slow, gradual development over 3,000 years as a result of the developing maturity of the coastline is a second series of short-term man-made changes over the last 150 years for which there is the following evidence.

1. Old photographs show that the reed cover was much more extensive and that the water level was lower.

2. There are reed stumps over much of the bed of Ireland Bay, suggesting that the reed fringe has retreated.

3. The reed fringes in the Lower Ley have a sharp edge suggesting that they are trimmed by small rafts breaking off and floating away. These sometimes drift ashore to start new colonies.

4. The "drowning" of culverts and farmland.

5. The two lakes are linked hydrologically by the flow of water from the Gara but there is a contrast between their ecology and the ecology of the lower Gara valley. We must account for the absence of floating peat from the Lower Ley and provide an explanation for the curious "floating jig-saw puzzle" that covers much of the Higher Ley.

In previous work and in the reserve management plan it has always been assumed that the areas occupied by reed and carr were gradually extending to encroach on the water area. I have no evidence to support these views—on the contrary the evidence presented here (Figs. 8 and 9) indicates that the water area has extended in both the Higher Ley and in Ireland Bay and that the water level is rising faster than the peat or sediment can build up. Thus the reed fringe is retreating and reed is invading pastures in the valley bottoms and around the Higher Ley.

The cause of these changes is fairly clear. In 1856 the A379 along Slapton Sands was turnpiked and the natural overflow channel for the Lower Ley was replaced with a culvert. No engineering details for the Higher Ley can be found but the vegetation pattern indicates that the natural outlet from the Gara would be at

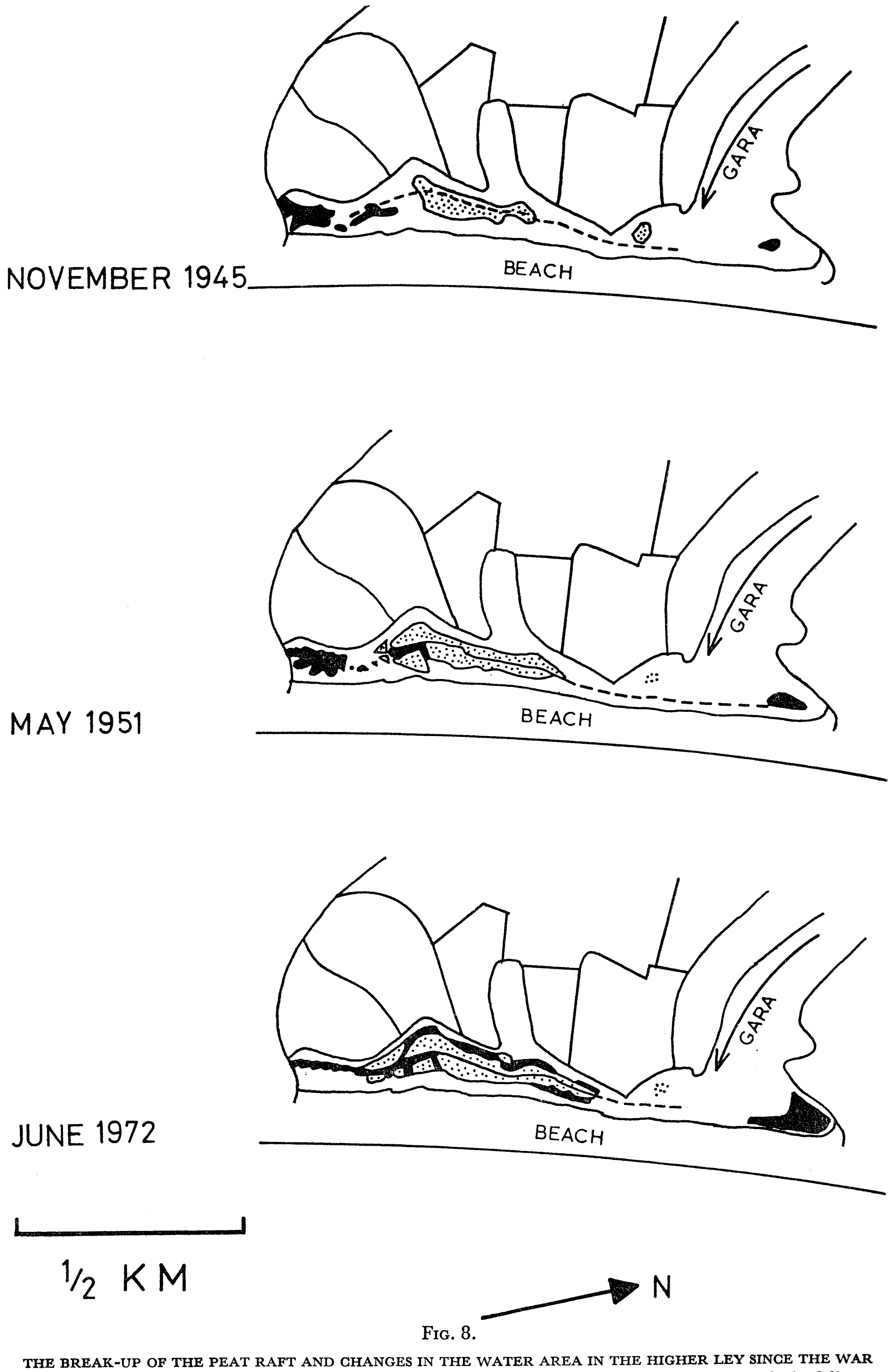

FIG. 8.

THE BREAK-UP OF THE PEAT RAFT AND CHANGES IN THE WATER AREA IN THE HIGHER LEY SINCE THE WAR

The diagrams are compiled from air photographs. The reed cutters channel is shown by a dashed line, open water is black and carr is stippled.

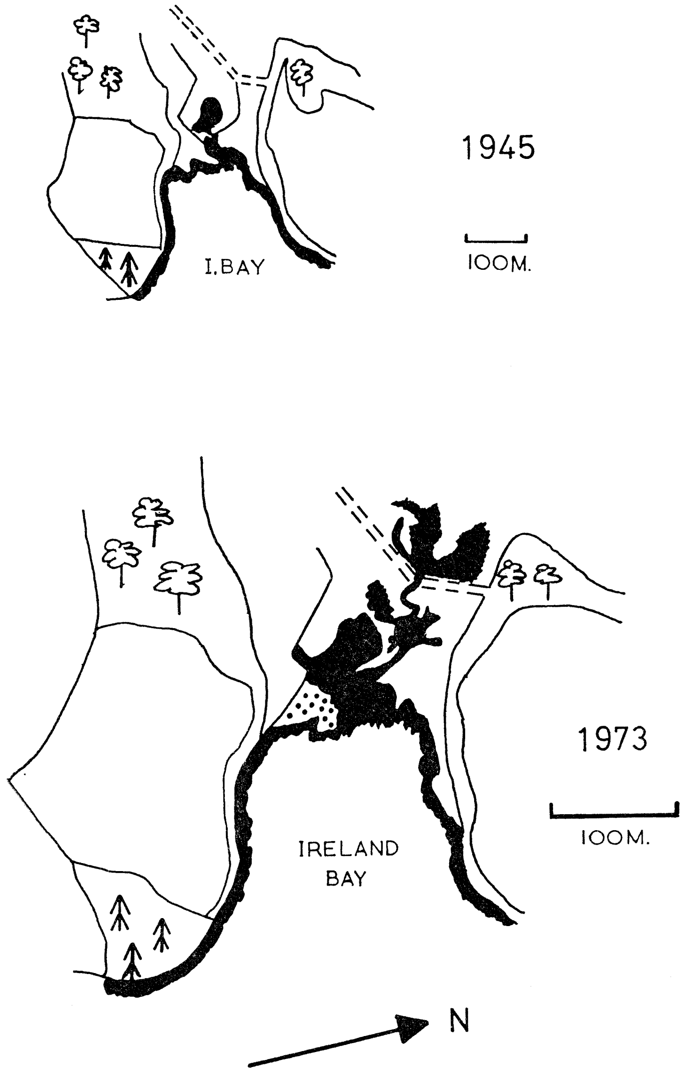

FIG. 9.

THE EXTENSION OF THE WATER AREA IN IRELAND BAY SINCE THE WAR.

The diagrams are traced directly from air photographs. Those from 1945 are on a smaller scale and show less detail but it is quite clear that the water area (solid black) has extended to flood the reed beds upstream of Ireland Bridge. The stippled area is now dominated by bulrush in place of reed.

Strete Gate and it is likely that it was diverted southwards to Slapton Bridge as part of the same programme. Since its original construction the weir at Torcross has been raised at least once and so maintains the surface of the two leys at an artificially high level.

Photographs from 1945 onwards show not only the extension of the water area but the reason for the accelerated break up of the peat raft in the Higher Ley. The open water areas that did not exist before 1944 correspond with bomb craters. These craters would certainly flood and encourage the start of erosion but, if the peat was afloat by 1944, the effect of bombs bursting in the water space between the peat and it's substrate would be an effective way of breaking up a mat of vegetation in which previously the reed cutters channel was the only incision.

Unfortunately, no contemporary records of these events are available. Local sources suggest that the level of the weir at Torcross was raised by the Whitley Estate to increase the area of the lake for sporting purposes, but there are no engineering details. During the winter 1943–1944 the Slapton area was used for battle training by the United States Army and air photographs from 1945 onwards show clearly the pattern and subsequent development of the impact craters of bombs and shells. Brookes and Burns (1969) have commented on the ecological significance of these activities. Much of the information on the macrophyte vegetation has been obtained from the same series of photographs and checked against the results of field work.

One of the most interesting points to emerge from this study is the recent age of the lake. The most recent C-14 date (1,813 $\pm$ 40 B.P.) was from a sample near the top of the peat section which is overlain by a sedimentary succession that includes the two marine bands. There is no data for the sedimentation rates at the time of writing but on this evidence alone the lake cannot be much more than 1,000 years old. The nature of the most recent sediments (black mud laden with diatoms) is similar to that of many other lakes under current investigation and confirms the view that the lake is becoming increasingly eutrophic.

Acknowledgements

I am grateful to erstwhile colleagues on the staff of Slapton Ley Field Centre and to many friends for advice and for assistance while preparing the maps for Figs. 4 and 5. Bore hole data was provided by the Institute of Oceanographic Sciences and the radiocarbon dating was undertaken at the Scottish Universities Research and Reactor Centre as part of the Institute's Start Bay programme.

Appendix

Mr C. D. Van Vlyman has supplied the following morphometric data for the Lower Ley basin. (survey datum=2·70 m O.D.)

Area		0·77 km^2
Volume	(minimum recorded)	0·86 $\times$ $10^6 m^3$
	(level at weir lip)	1·19 $\times$ $10^6 m^3$
	(maximum recorded)	2·08 $\times$ $10^6 m^3$
Mean depth		1·55 m
Maximum depth		2·80 m
Catchment area		50 km^2
Area occupied by reed beds		16·3% of total
Length		2·32 km
Mean width		330·6 m
Length of shoreline		6·67 km
Shoreline fringed by reed beds		85·4%

References

Brookes, B. S., and Burns, A. (1969): The Natural History of Slapton Ley Nature Reserve III. The Flowering Plants and Ferns. *Field Studies*, **3** (1), 125–157.

Crabtree, K. and Round, F. E. (1967): Analysis of a Core from Slapton Ley. *New Phytologist*, 66, 255–270.

Hails, J. R. and I.O.S. Staff (1975): Submarine Geology, Sediment Distribution and Quaternary History of Start Bay, Devon. *Journ. Geol. Soc.*, **131**, 1–101.

HAILS, J. R., (1975): Some Aspects of the Quaternary History of Start Bay, Devon. *Field Studies*, **4** (2), 207–222.

HASLAM, S. M. (1968): The Biology of Reed (*Phragmites communis*) in Relation to it's Control. *Proc. 9th Br. Weed Control Conf.*, 392–397.

HASLAM, S. M. (1970): The Performance of *Phragmites communis* Trin. in Relation to its Water Supply. *Ann. Botany*, **34**, 366.

JELGERSMA, S. (1966): *Sea Level Changes During the Last 10,000 Years.* Roy. Met. Soc. Proceedings of a Symposium on World Climate from 8,000 to 0 B.C., 54–71.

JOHNSON, D. W. (1919): *Shore Processes and Shoreline Development.* New York

KIDSON, C. and HEYWORTH, A. (1973): The Flandrian Sea Level Rise in the Bristol Channel. *Proc. Ussher Soc.*, **2**, 565–584.

MERCER, I. D. (1966). The Natural History of Slapton Ley Nature Reserve I. Introduction and Morphological Description. *Field Studies*, **2** (3), 385–404.

MOREY, C. R. (1974). Visit to South Hams. *Proc. 101st Conf. Inst. Mun. Eng.*, Torbay 1974, **32**

MOTTERSHEAD, D. (1971): Coastal Head Deposits Between Start Point and Hope Cove. *Field Studies*, **3** (3), 433–453.

STEERS, J. A. (1946). *The Coastline of England and Wales.* Cambridge.

ZENKOVICH, V. P. (1967): *Processes of Coastal Development.* London.