LAND-SHELLS IN THE INFRA-GLACIAL CHALK-RUBBLE AT SEWERBY,
NEAR BRIDLINGTON QUAY.

BY G. W. LAMPLUGH, F.G.S.

In the coast-sections around Flamborough Head the Glacial deposits are frequently underlain by an earthy chalk-rubble of variable thickness, to which the term "chalk-wash" was applied by Mr. J. R. Dakyns.* This chalk-rubble usually rests directly upon the chalk, but at the crest of the buried rock-cliff beneath the drifts at Sewerby near Bridlington Quay, the rubble passes off the chalk and covers the fossiliferous "Infra-Glacial" beds which have been preserved under the lee of this old cliff, as shown in the accompanying section (Fig., p. 94).† By previous researches it has been proved that the chalk-rubble to the westward of the old cliff not only descends rapidly to sea-level but sinks still lower as we approach Bridlington Quay, so that, near Sands Cut, its top, as proved by borings through the Basement boulder-clay, lies 22 feet below the level of the shore.‡

Though it has long been recognised that this chalk-rubble probably represents the sub-aerial waste of an old land surface,§ the material had not hitherto yielded any fossils except a single limb-bone of *Bos* or *Bison*.|| While living in the neighbourhood I searched it repeatedly without success; but during a recent visit to Bridlington, in examining a good exposure of the bed on the foreshore between 200 and 300 yards S.W. of the Sewerby buried cliff, I noticed some thin seams of brown loamy earth intercalated with the fine chalk-rubble, and found that small

* Proc. Yorks. Geol. and Polytec. Soc., vol. vii., pp. 249-252.

† "Report on the Buried Cliff at Sewerby," Proc. Yorks. Geol. and Polytec. Soc., vol. ix. (1887), pp. 382-392; and Rep. Brit. Assoc. for 1888.

‡ Proc. Yorks. Geol. and Polytec. Soc., vol. xi. (1889), p. 284.

§ J. R. Dakyns, op. cit., and G. W. Lamplugh, Quart. Journ. Geol. Soc., vol. xlvii., p. 414.

|| See "Drifts of Flamborough Head," Quart. Journ. Geol. Soc., vol. xlvii., p. 394.

land-shells occurred plentifully in this earth. The chalk-rubble on the foreshore in which these shells were found was about 30 yards from the base of the present cliff, and extended in a strip from three to five yards wide for about 150 yards, disappearing southward beneath boulder-clay which was exposed for about 50 yards further. I had not before seen so good an exposure on this part of the shore.

In the cliff just opposite the middle portion of the exposure, the chalk-rubble is well seen in section, having a thickness there of ten feet. In this section it is immediately covered by boulder-clay, the junction-plane being sharp and definite. After finding the shells in the shore-exposure I was able to detect them also in an earthy seam in the rubble near the base of this cliff (Fig., p. 94).

The shells are in a very fragile state, and at present only one species has been recognised:—*Pupa muscorum*.* But a small *Helix* is probably also present, though not identifiable in the material submitted to palæontological examination at the Museum of the Geological Survey.

Samples of the shelly earth were washed and sifted in the hope that it might yield other organic remains; but with the exception of one small carbonaceous fragment, which may have been of vegetable origin, no other fossils were found.

The chalk-rubble is almost wholly composed of small angular fragments of chalk ranging from one-eighth to half an inch in diameter, firmly set in a matrix of yellow silty clay which may represent the residue from decomposed chalk. Occasionally there are seams of larger fragments of chalk, up to one to two inches in diameter, but these are comparatively rare, and it is singular how comparatively regular and even has been the trituration of the hard rock which has gone to form the bed. The chalk-rubble appears to be unlike any superficial deposit which is at present being accumulated from the waste of chalk surfaces, and it probably represents the weathering of the chalk slopes under peculiar climatal conditions which

* I am indebted to Mr. E. T. Newton, F.R.S., for this determination.

prevailed immediately before the invasion of the district by the ice-sheet.

Besides chalk fragments, however, the bed contains a fair sprinkling of small chips of grey flint and of well-rounded grains of quartz-sand. Close search also reveals the presence of a few small fragments of hard grey grit or quartzite and of other stones foreign to the district, including a greenish basaltic rock, though these are very rare. The occurrence of the flint chips is remarkable, as the chalk which forms the neighbouring slopes contains no flint, and the nearest outcrop of the flinty Middle Chalk, from which the fragments appear to have been derived, lies over two miles distant to the northward, and is separated from these slopes by the wide pre-Glacial depression of the Bempton Valley.

Another significant fact is that although the bed at this place is made up almost exclusively of fine detritus, I noticed in the cliff-section during a previous visit to the locality (in November, 1902) an angular block of hard yellowish-white sandstone or grit, measuring $1\frac{1}{2}$ feet by $1\frac{1}{2}$ feet by 1 foot, embedded at the base of the rubble just above the blown sand of the Buried-Cliff Beds. This boulder is probably from the same source as the small fragments of grit mentioned above. It is the only large boulder which I have seen in the chalk-rubble at Sewerby, though many years ago I found a boulder of quartzite 21 inches in diameter in the chalk-wash which underlies the drift at Danes' Dyke, $1\frac{1}{2}$ miles farther eastward.* It is noteworthy that a few erratic stones, chiefly of sandstone and basalt, were obtained in excavating the old beach-deposit at the foot of the Sewerby buried cliff; and that in the land-wash which rested on this old beach and was covered by blown sand, we found four species of small land-shells, including the species which has now been found in the chalk-rubble.†

* "Drifts of Flamborough Head," *Quart. Journ. Geol. Soc.*, vol. xlvii., p. 397.

† Reports on the Buried Cliff, *op. cit.*

CLIFF-SECTION AT SEWERBY, NEAR BRIDLINGTON QUAY.

The Buried Cliff of Chalk runs in obliquely behind the line of section & the covering beds slope away from it towards the spectator.

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Glacial Drifts.

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- 3 — "Purple" Boulder-clay splitting into two bands, South-Westward, with stratified material intervening.
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- 1 — "Basement" Boulder-clay including contorted patches of loam, chalk-rubble, etc. towards base.

Infra-Glacial Beds.

- D — Chalk-rubble. (see text)
- C — Blown Sand, with bones, etc. (a land-shell found in a loamy band near top)
- B — Land-wash banked against the buried cliff, with bones & numerous land-shells.
- A — Old Sea-beach, with bones & marine shells.

One point of consequence in the occurrence of the land-shells now found in the chalk-rubble is that their position on the shore is several feet below the level of the ancient beach, and furthermore that the bed in which they are enveloped is known to descend at least 25 feet lower than this level,* and is probably prolonged to a still greater depth. We thus obtain definite proof that an elevatory movement, already postulated on less direct evidence,† has followed the stage of slight depression marked by the Sewerby Buried Cliff.

Another point of great interest is the close correspondence which can be now established between the Infra- (or pre-) Glacial beaches of South Wales, as described by Mr. R. H. Tiddeman‡; of County Cork, recently discovered by Messrs. Muff and Wright§; and of East Yorkshire. In each case the old beach is covered by blown sand, and then by a wash of local rubble or "head," and the whole series hidden under boulder-clay; and in each case there is proof of some degree of elevation before the invasion of the country by ice.

The presence of the flints and of occasional extraneous fragments, and especially of the grit boulder, in the chalk-rubble, together with the extraordinary poverty of the fauna (if, indeed, this be not merely an accident of preservation), point to the likelihood that the ice-margin was already not far distant from the neighbourhood when the bed was being formed. We have still much to learn about the succession of events during the early stages of the Glacial Period in England; and therefore every little glimmering fact that may aid in dispelling the obscurity has its value.

* Proc. Yorks. Geol. and Polytec. Soc., vol. xi., p. 284.

† "Drifts of Flamborough Head," op. cit., p. 416.

‡ Rep. Brit. Assoc. for 1900 (Bradford), pp. 760-762.

§ Rep. Brit. Assoc. for 1903 (Southport).