There can be no reasonable doubt of the vegetable nature of this fossil, and I think its affinity to the vascular Cryptogams is most clearly shewn.

These Lower Arenig Rocks, from whence the specimen was obtained, rest apparently quite conformable on Upper Lingula-flags,¹ and underlie the true Arenig or Skiddaw rocks. Nearly all the species obtained from these beds are new, and they indicate a fauna intermediate between Tremadoc Rocks, and the true Arenig Rocks. Indeed, in the report to the British Association, by Mr. Salter and myself, in 1866, they were classed as Tremadoc Rocks; but I have since thought it advisable to separate them and to place them in an intermediate position. The Brachiopoda from these rocks have been described by Mr. Davidson (GEOL. MAG., Vol. V. p. 303), but all the other species are yet undescribed.

Eophyton (?) explanatum, n.sp., Fig. 1. Pl. XX.—A raised, moderately convex stem, about 4 lines in breadth; widening, however, and becoming somewhat compressed at the joints. The surface is ribbed, and furrowed along its whole length. At the lower joint (*a*) the ribs bend outwards, evidently to form a branch. The joint is obliquely placed, widened out, and its course distinctly marked by a deep sulcus. The cortical substance is very thin, and can be removed to shew the internal structure. The internal structure is made up of compressed columns, running the whole length from joint to joint, evidently of a tubular nature, and bound together by very thin tissue. These are well shewn at *b*. At *c*, being the base of the stem, the broken ends are visible. Figs. *d* and *e* are these parts magnified.

Fig. 2 most likely belongs also to this plant, but the characters are not well marked.

Unless *Eophyton Linnæanum* is proved to have a jointed stem, and an internal structure similar to our specimen; it will probably be necessary to make a generic distinction, but at present it is better to retain this under Dr. Torell's generic name.

III.—ON THE PRETENDED "RAISED SEA-BEACHES" OF THE INLAND SLOPES OF ENGLAND AND WALES.

By G. POULETT SCROPE, F.R.S., F.G.S., etc.

IN the number of this Magazine for July, 1866, p. 293, I ventured to characterize as "preposterous," the opinion advanced by Mr. D. Mackintosh in two preceding papers (GEOL. MAG., Vol. III. p. 69, and p. 163) that the very numerous terraces that occur on the sides of the Chalk and Oolitic hills of the southern and western counties were, "without doubt, *raised Sea-beaches*," affording, therefore, evidence of the *very recent* elevation of these hills from beneath the sea-level, since the complete excavation of the existing valleys.

¹ So marked in the Geological Survey Maps. I am inclined, however, to think that they are representatives of the Tremadoc rocks, for *Ling. Davisii*, which is the only fossil present, is equally characteristic of Tremadoc rocks, and reaches here also into these Lower Arenig rocks.

Mr. Mackintosh replied in a brief paper, in which he refused to accept my correction of his theory (Vol. III. p. 381), declaring that, "so far as his observations have extended, the *plough*" (to the action of which I had attributed the formation of these terraces) "would appear to obliterate rather than form regular systems of terraces such as he had described."

In his recently issued volume, "The Scenery of England and Wales; its Character and Origin," which was reviewed in the October number of this Magazine, Mr. Mackintosh repeats and enforces his views as to the *marine* origin of these terraces, with a contemptuous allusion to my "Agricultural theory" (p. 92).

Now, since the causes which have modelled the existing surface-forms of this island have a real geological interest of no little moment—especially as the same causes, if of a geological character, were no doubt at work very generally throughout the world during the same period,—and as those to which Mr. Mackintosh assigns the terraces in dispute indicate a very recent emergence from the sea, and elevation of the entire island by at least a thousand feet; and also that this process took place through a series of slight steps or jumps locally of a few feet at a time, corresponding to the intervals of height between the numerous repeated terraces,—the question becomes one not of mere controversy between individual geologists, but of some importance in its bearing on general geological history. This consideration will, I hope, be my sufficient excuse for once more calling attention to the matter in dispute between Mr. M. and myself. I must refer the readers of the Magazine to my paper already mentioned (July 1866, p. 293) for the arguments employed by me in support of the agricultural origin of these terraces, popularly called *Lynchets*, or *Balks*, being unwilling to repeat them here. But as Mr. Mackintosh reproduces his theory of their marine origin in his present volume, with some additional illustrations and examples, I will quote some passages from that work in order to show the extent to which, if adopted, it would carry us, appending as we go on a few brief comments.

In p. 85, he instances "the successive levels of the Brent knoll and its connected platform" as "terraces of marine erosion, *which could never have answered any human purpose*," but which may be explained by "the action of a not very powerful sea, at different tidal levels, during a gradual rise of the land." How or why these levels could not have answered the purpose of facilitating the culture of the steep slope—especially to the population which at one period encamped for safety on the summit of the knoll, Mr. M. does not explain. He proceeds to say, "In the adjoining district traversed by the Glastonbury and Temple Combe Junction, a geologist becomes bewildered among the thickly crowded variety of these denudational phenomena. Among them he can here and there discover single terraces and sets of terraces, *nearly all corresponding to the outcrop of the strata, and therefore not artificial.*"

Why so? If the outcrop of a stratum or series of strata of rock harder than the rest, on the slope of a hill, be tolerably horizontal,

it would follow as a matter of course that the softer surfaces of the slope, above and below it, will have been preferably subjected to aration, and in time the ordinary result would appear in the accumulation of a considerable depth of silt and gravel—the washing of the plough-disturbed surface above—on the brow of the harder stratum, while its base would be eaten away through the action of the plough, and the loss by descent to a lower level of the matter so disturbed; thus by degrees a small cliff or bank (balk) would be formed, chiefly consisting of hard rock, between the upper and under arable terraces. And this surely must be called an “artificial terrace,” though the occurrence of a hard stratum of “natural” rock directed the operations of the plough. Indeed, it is obvious that in all cases of the alternation of harder and softer groups of horizontal strata in a hill-side, the agriculturist would follow the direction of the softer portions in ploughing the slope, leaving the harder as banks to support his arable terraces, just as the vine-growers of the sunny slopes of France, Germany, and Italy, avail themselves of the outcrop of harder strata to assist the formation of the walls which support the “artificial” terraces, built up by them to check the descent of soil from above.

Mr. Mackintosh tells us in his preface that he has never been out of this island. It is therefore probable he is not aware of the extent to which the cultivation of hill-slopes by the system of artificial terraces is practised throughout the continent, nor of the general character of such terraced slopes. Otherwise, I think, he would hardly have presented his readers with the example of “Terraces of Marine Erosion,” of which the accompanying woodcut is a copy (p. 88).

FIG. 1.—PROFILE OF TERRACES ON THE SIDE OF A CHALK HILL NEAR TWYFORD.

On this he remarks—“Unless we can conceive of our ancestors having been endowed with so great a *taste for the picturesque* as to dig out chalk for burning in a series of ornamental steps or shelves, I can see no agency likely to have formed these terraces excepting *oceanic currents*, at different levels, with or without floating ice” (!). As a “pendant” to this example of a steep-terraced hill, I copy one other of Mr. Mackintosh’s cuts representing “the most regular series of terraces I have yet seen in the Chalk district, which occurs on the side of a hill to the south-west of Stockbridge, the slope being so

very gentle that there could have been no inducement to break it up into terraces as a means of facilitating cultivation."

FIG. 2.—TERRACES NEAR STOCKBRIDGE.

It was to meet such cases as these of gentle slopes so terraced that, in my paper above-mentioned (Vol. III., p. 293), I suggested the probability that each of such terraces might have been in early times strips of land held by separate occupiers (as was up to a very late period the custom in many "common fields," and is at present through a large part of France), the "bank" having been originally perhaps only a grassy border, or a slight fence, either of which would be enough to arrest the descent of silt during rains from the surface of the ploughed strip above, and by its long-continued accumulation upon this edge raise there by degrees a steep bank, while the slope above would, by the same process, rise into a nearly level terrace. As a practical proof of the correctness of this theory, I stated that these banks might be observed by any long resident in the country to *grow* in height, and gave a cut representing one that I had myself seen *wholly created* within a few years by this process. I will now add another to exemplify the fact that it is by no means necessary that a fence should exist along the lower edge in order to stop, by its resistance, the descent of silt, gravel, etc., from the slope above. I could adduce numberless instances in which, when there did exist such a fence, the silt has been deposited in a bank stopping short, and leaving an interval like a ditch, of a yard or two wide, between itself and the fence below. It happens in this wise (see Fig. 3),

FIG. 3.—TERRACE AND BANK CAUSED BY DESCENT OF SILT, etc.

A, B represents the profile of a hill slope, towards the base of which a fence,—say a stone wall, c, d separates the arable field B, E from the one below A, D; the dotted line D, F, represents the original surface. But by the continued ploughing of that surface in horizontal furrows, aided by the wash of the disintegrated soil during rains, much of it has been carried down to form the bank and terrace, D, E, F, at the bottom of the field. The descending silt, however, does not actually

reach the wall, for the reason that the plough never can be driven within a few feet of it; a small strip of unploughed and consequently grassy surface will always intervene between the last furrow and the fence, and however slight this obstruction, it is sufficient to check the descent of silt, and cause it to accumulate in the lowest furrow. By repetition of this process through a series of years, the bank is formed, maintaining a certain distance from the wall, as seen in the woodcut. And thus, it will be perceived, that the bank and terrace above, would be produced equally, whether a fence existed below it, or only that the lowest limit of aration was originally marked by a grassy ridge, a few inches in height.

All this minute explanation of the humble origin of these banks, is, however, mere moonshine to Mr. Mackintosh, who prefers to bring the ocean up to and above the tops of our Chalk and Oolite hills, to account for the petty features with which their sides are scored. It is true that in his recent volume (p. 88) he seems, though in an equivocal manner, to admit that *some* of the banks, terraces, etc., *may* have been formed artificially; while in his earlier paper he denied this origin to any. He now only ventures to say, "It is, I think, by (marine) currents acting on an easily moulded material, that *many* of the terraces of the chalk downs can be most satisfactorily explained." This, of course, makes the intervention of the ocean, and consequently the recent elevation of the surface of the island from beneath it, just as indispensable as if *all* the terraces were ascribed to its erosive action. So that nothing is gained by the evasive admission. Only a perplexing doubt is introduced as to which of the "thousands of terraces" to be seen at different levels on the hill-sides of Wiltshire, Dorset, Hants., and other of our counties, are to be ascribed to the work of Giles Ploughman, and which to mighty Neptune. They were all "raised sea-beaches" in Mr. Mackintosh's paper of July, 1866, now some are, and some are not! I venture again to maintain that *all* are of artificial origin; and that consequently no proof is to be derived from them, either of the very recent sojourn of the sea upon the summits of our hills, or of the "very limited amount of atmospheric denudation in the Chalk and Oolite districts," which was another most important inference drawn from these terraces by Mr. M. (Vol. III., p. 69). They, in truth, lead to the very opposite conclusion, showing indisputably how largely atmospheric influences have altered the form of the surfaces exposed to them, within periods of a very few years' duration.

It is hardly worth while to notice some futile objections urged by Mr. Mackintosh to the agricultural origin of the terraces, such as that the strips of arable could not have been held "in severalty," because such divisions are not mentioned in title-deeds, etc.; whereas it is notorious that nearly all old terriers of estates contain mention of single acres, half-acres, or other small quantities of land, so held in the common arable fields of the manor. But, of course, in suggesting the possibility of the terraces having in some cases originated in their having been held in early times by different cultivators, I by no means intended to suppose this to have been the

fact in all cases. Probably also many such terraces were intentionally formed by the farmers, with the pick-axe, with the object of preventing the descent of soil to the bottom of the hill, and of widening the arable surface; as is constantly done by the continental cultivators of similar slopes. Again, Mr. Mackintosh says, "Many farmers have assured me that there is now, and has long been, a general desire to plough down the 'lynchets,' and that formerly their number was much greater than at present" (p. 89). No doubt, in the course of time, as two separate strips, "or lands," become united in one estate, or held by the same tenant, it would be for his interest to "plough down" the bank between them, which, being composed chiefly of the finest mould, washed down in preceding years from the slope above, would enrich the impoverished land at its base. And, indeed, this occasional "ploughing down" of the banks accounts satisfactorily for their partial disappearance on some points, as well as their "gradation into the more general slope of the ground," which naturally seems to have "bewildered" Mr. Mackintosh, on the assumption of their marine origin. But, supposing the banks to be "marine terraces," and, therefore, often composed of shingle and shells, this "general desire to plough them down," would be unaccountable. In truth not a single example of a terrace so composed has been produced by Mr. Mackintosh, and I venture to assert none such will ever be found in the situations indicated in his theory.

We all know what a sea-beach is. The Chesil bank is an admirable example. There is another stretching eastwards, along many miles, from the base of Beachy-head to Hastings. They are composed, like all sea-beaches, I believe (differing in some respects from flat sandy shores), of rolled pebbles or boulders, with or without an admixture of sand, broken shells, and other sea-wrack. Has Mr. Mackintosh examined any of his "raised sea-beaches" and found them, or even any one of them, to be so composed? Not one! Has he produced a single sea-shell found in any of them? Not one! Throughout his whole description of these numberless banks and terraces, I cannot find that he has even attempted to examine the composition of any—with the single exception of one of a "Series of Terraces near Llangollen," "*the finest series of undoubted Old Coast-lines or raised Sea-beaches* I have yet met with, on the face of a hill to the south of Llantysilio railway station—the highest terrace reaching an elevation of at least 1500 feet." One of these, *close to the railway station*, Mr. Mackintosh *did* examine (I presume while the train was stopping, as he says "*I had not time to make a particular examination*")—but "it seems covered with *fine clay*, mixed with small stones, some of which are much rounded, and, *where the soil has been thrown up by moles*, it appears mixed with the refuse of decayed shells"—land shells, no doubt. And *this* is the sole *fact* or observation relative to the composition of these "innumerable raised sea-beaches," which Mr. Mackintosh affords his readers, if we except the statement that "Mr. Codrington, F.G.S., and others, have ascertained that a number of the terraces have a deposit of ap-

parently made earth on their brows" (p. 66). Of course; and this "made earth," or, in other words, silt and soil, with land shells, fine gravel and small stones, loosened by the plough from the surface-slope above, and washed down by the rains until some hedge, or wall, or even less trifling boundary, more or less horizontal, checked the downward wash of surface matter, will be found, if I mistake not, to form the substance of all these terraces and banks—except where some harder stratum crops out from the hill-side, and gives a support to the arable terrace above.

FIG. 4.—TERRACES NEAR LLANGOLLEN, AS SEEN FROM THE HILL NORTH OF LLANTYSILIO RAILWAY STATION.

No one, of course, disputes the existence of true sea-cliffs and escarpments, or of raised sea-beaches on some of the coast-lines of our island, or that some of the latter may penetrate its estuaries, and be found at considerable heights above the present tidal level. Where sufficient evidence of these latter facts is produced, they are, and will be, readily accepted by all geologists. It is to the innumerable minor banks and terraces (popularly called balks and lynchets) which Mr. Mackintosh truly describes as scoring the sides and reaching to the summits of many inland hills in the Cretaceous and Oolitic, and other formations of our island, that my remarks refer. These, I believe, to be of artificial origin,—to be owing to the disturbing action of the plough and the mattock on the surface-slopes, aided by downward rain-carriage of the loosened soil—a process which is *visibly* going on wherever a hill-side is under cultivation. And I look on Mr. Mackintosh's notion of their being "raised sea-beaches" as a preposterous theory without a shadow of foundation.

On the whole, it is evident that before Mr. Mackintosh can be accepted as a reliable authority by his readers on the "Causes of Denudation, and the origin of Natural Scenery throughout England and the World," he must unlearn many of his present notions upon the "very limited power of atmospheric," and the almost exclusive agency of "marine denudation," in shaping the surface of our continents, which compose the substance of his recent volume. If as a lecturer he repeats this theory of denudation to an agricultural audience in the southern

counties, he will be liable to some such muttered interruption from an incredulous old farmer, as that of Edie Ochiltree to the Antiquary's far-fetched assertions—"Sea-beach here, sea-beach there; *I mind the bigging of 'em.*"

IV.—ON THE MIDDLE PLEISTOCENE DEPOSITS.

By Professor HARKNESS, F.R.S., F.G.S.

THE superficial deposits of the Co. of Wexford, containing a rich marine fauna, have been referred to in Professor E. Forbes's Memoir on "The Geological Relations of the existing Fauna and Flora of the British Isles."¹

In an appendix to this memoir the several shells which have been obtained from the superficial deposits of this portion of Ireland are mentioned. A list of the fossil contents of these deposits had been previously given by Sir Henry James, who first pointed out the occurrence of these shell-bearing strata in the Journal of the Dublin Geological Society, Vol. III. The fossils mentioned in this list have been also determined by Professor E. Forbes.

The strata affording these fossil shells are described by Sir Henry James as very extensively developed in the Co. of Wexford, and occupying an area forty miles in length, by from eight to nine miles in breadth. They consist of sands and gravel and drift, and repose upon rounded pebbles." On the sides of the Firth Mountain they attain an elevation of 400 feet above the level of the sea. Their thickness near Blackwater is said to be 174 feet, and their base is nowhere seen.

On four of the sheets of the Geological Survey Maps of this part of Ireland (sheets 47 S.E., 47 N.E., 41 S.E., and 41 N.E.), these strata are referred to as follows:—"The low lands of this coast and the interior up to a height of between two and three hundred feet are covered by Pleistocene deposits, consisting of marls interstratified with sand and gravel, containing Arctic and other shells, chalk-flints, pebbles of Antrim chalk, jasper, coal, etc., and magnetic iron sand." Many of the species of shells which occur in these beds are in the Museum of the Geological Survey of Ireland, and the several localities from whence the specimens have been obtained are recorded on the underside of the slabs upon which they are mounted. By the kind assistance of Mr. Baily, Palæontologist to the Irish Survey, I have been able to give the following as localities from whence these specimens have been derived:—Ballyteige, Killiley, Rathaspick, Castle Ellis, Killisk, Ballyhuskard, Artramon, Ballyvaldon, Ballyknockan, Killmackridge, St. Margaret's, Killinkorley Clonmure.

The portion of the Co. of Wexford where these superficial deposits occur is marked by a circumstance which at once recalls, to the minds of those who have seen them, the Boulder-clays of Lancashire and Cheshire, and their associated strata. Great numbers of pits are seen scattered over the parts of Wexford where the superficial

¹ Memoirs of the Geological Survey, Vol. I.